Instruments and AUTOMATION

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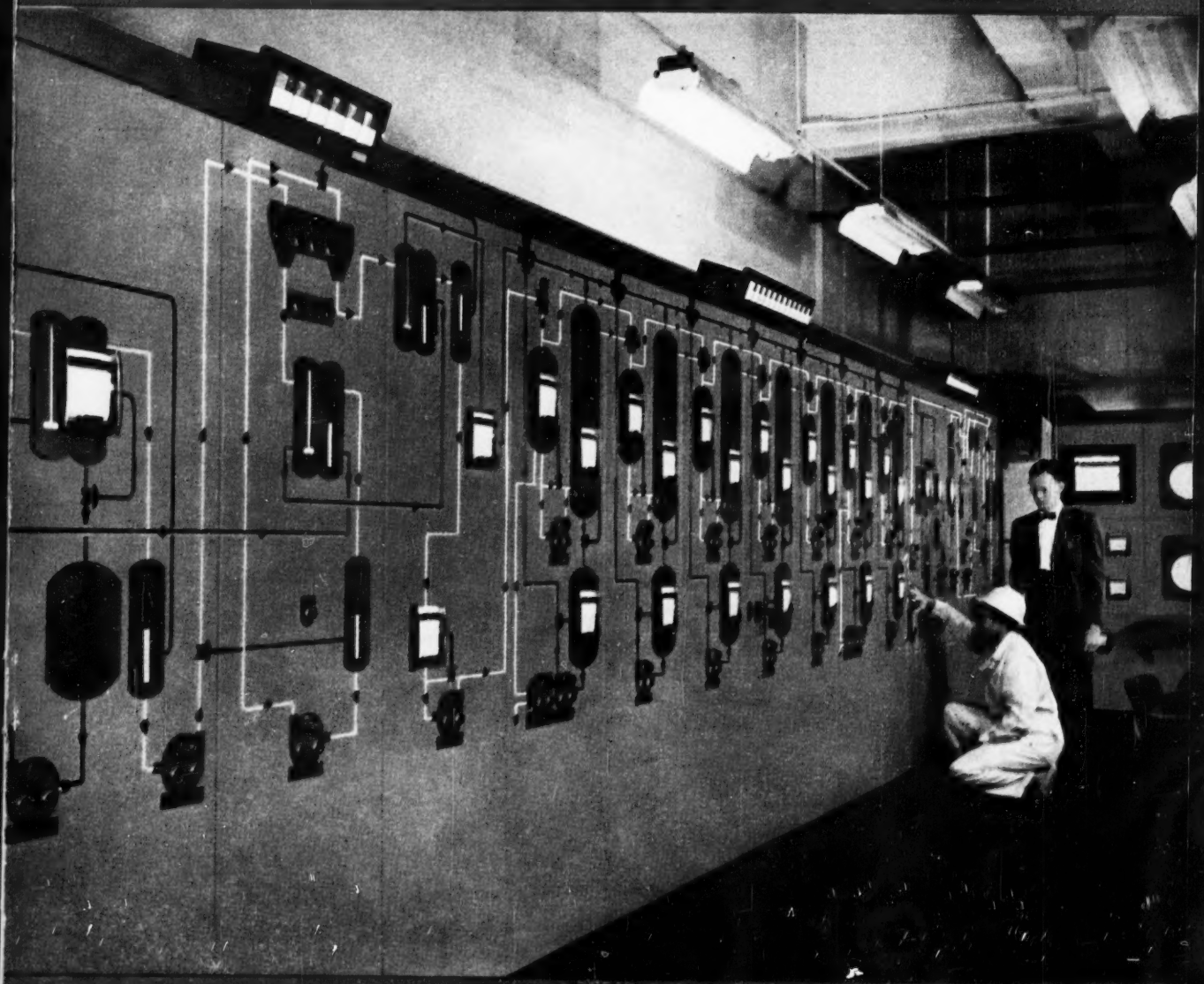
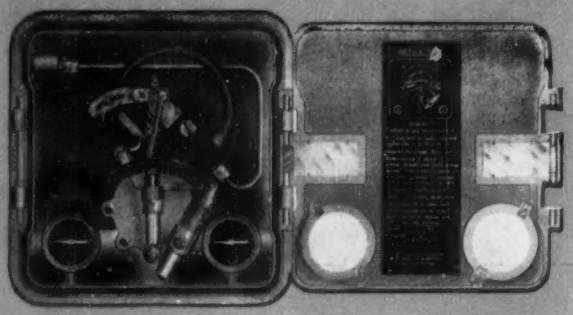


Graphic panel at the Oak Ridge National Laboratory (for story, see page 496).

Vol. 27 · No. 4
APRIL · 1954

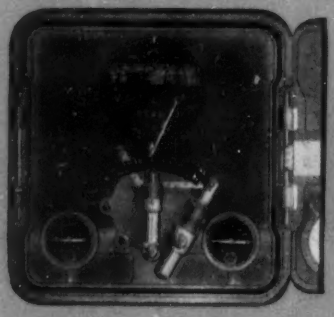
BS&B Announces:

...An Even Better Pressure Controller— Climax Type 1440



The Climax Type 1440 Pressure Controller (non-recording) is designed to handle both positive and negative pressures, from high vacuum to pressures of up to 10,000 lbs. Bourdon Tube actuated—with all tubes, bellows assemblies, feed orifices and bleed nozzles calibrated—the Type 1440 is an instrument of utmost accuracy. Proportional band and On-Off or Maximum-Minimum snap action adjustment is easily made without additional parts. Snap action may be adjusted to pressures up to 75% of the limits of the Bourdon Tube rating.

...An Even Better Liquid Level Controller Pilot...Climax Type 1450



The type 1450 Liquid Level Controller Pilot was developed for use and mounting on any Climax Type 888, 888-LF, 887 and 889 displacement liquid level controllers where a torsion tube transmits float movements to reflect changes in liquid level or a change in gravity of the controlled liquid. Its interchangeability of parts with those of the Type 1440 Pressure Controller is an advantage which reduces stocking parts.

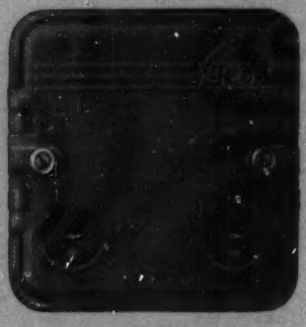
Type 1450 features a very wide "throttling" range calibrated from 0% to 100%. A specific gravity index is provided and offers a method of compensating for various gravities of liquids, or for inter-face services, where the "throttling" range is kept exact in its relationship to the specific gravity setting.

A novel feature of the Type 1450 is its adjustability, without use of special parts, for "snap" or "on-off" action. This is useful when it becomes desirable for the diaphragm control valve to fully open or close when liquid level height reaches a desired "high" setting, and to react in an opposite manner at a desired "low" setting. The amount of liquid level change from open to shut positions of the control valve may be varied up to 75% of displacement element length.

Improved Features of Types 1440 and 1450:

1. Weatherproof case of die-cast aluminum designed for universal mounting.
2. Compact size—8" x 8" x 4".
3. Door hinges to left or right, as desired.
4. Straight line piping.
5. Proportional bellows, calibrated, spring opposed.
6. Micro-adjusted set-point, graduated.
7. Molded diaphragms in power unit.
8. Easy parts replacement or assembly.
9. Feed orifice cleaner.
10. Snap action available over 10% to 75% of tube range without additional parts. (Applies to Type 1440 only.)
11. Pilot action reversible by moving a single link, without tools.
12. Elimination of superfluous linkages, resulting in easier adjustability and greater sensitivity.

Types 1440 and 1450 Have Been Developed and Thoroughly Field Tested for More Than Two Years!



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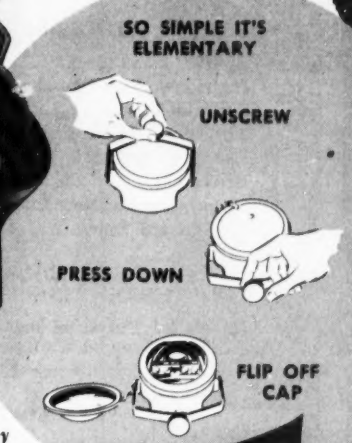

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Instruments and AUTOMATION

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By Raymond C. Baird

COVER STORY

At Oak Ridge National Laboratory, operated by Union Carbide and Carbon Corporation for the Atomic Energy Commission, pilot plants for new chemical processes are instrumented using narrow sectional units which can be modified or replaced easily to keep pace with equipment improvement and process refinements.

With reference to the instruments on the panel, curtain-type receiver indicators on the first three sections were manufactured by Panellit, Inc., Chicago, Ill.

Miniature recorders in the main center section are composite in that the recorder function is combined with a selective manual, automatic, or service-operating section. These are manufactured by the Foxboro Company, Foxboro, Mass.

The annunciators were manufactured by Tigerman Engineering Company, Chicago, Ill.

The graphic stripping and symbols were manufactured by the Foxboro Company with all special symbols, such as pumps, centrifuges, multi-port valves, etc., being designed and fabricated at Oak Ridge National Laboratory.

The yellow smock signifies that the operator is assigned work in a contaminated area. (Photo is by courtesy Union Carbide and Carbon Corp.)

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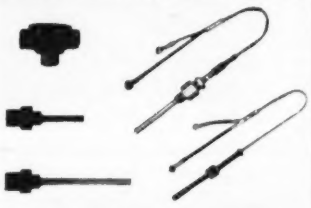

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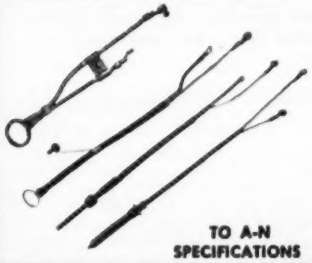

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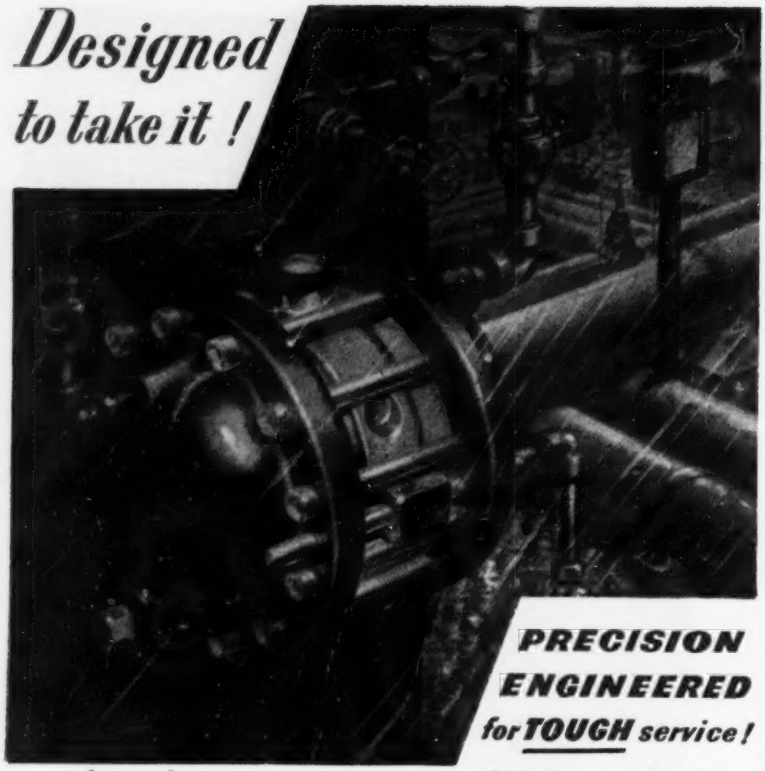

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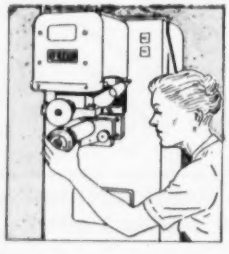

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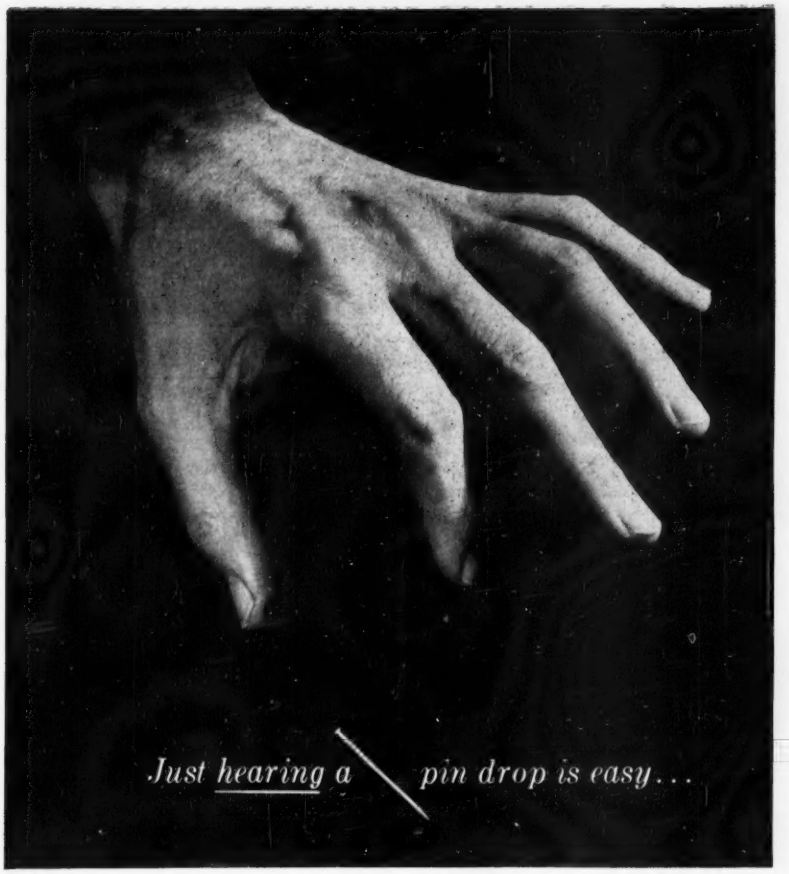

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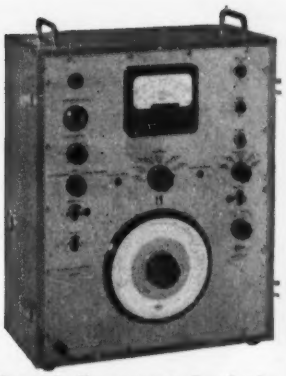

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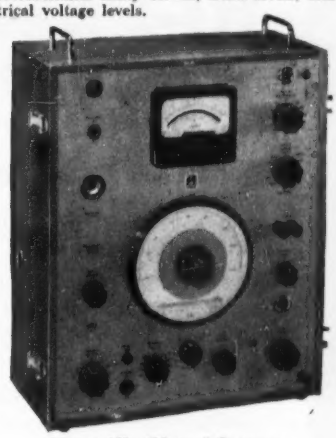

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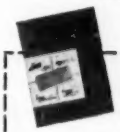

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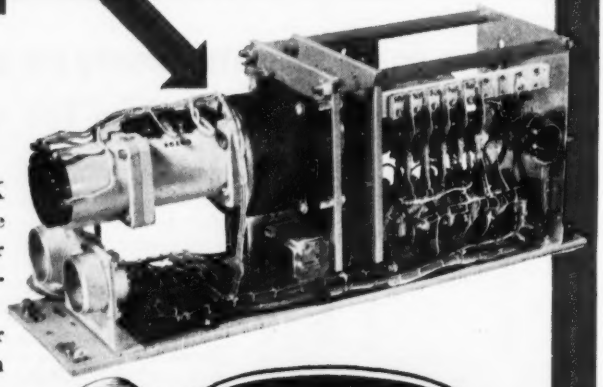

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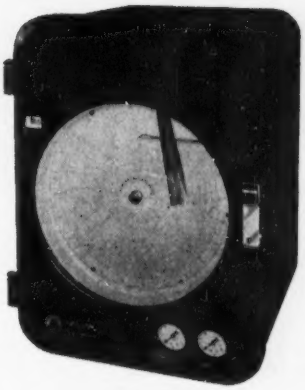

RING BALANCE METERS

Where flow measurements *must* be made with a low full scale differential, the logical choice is the Hagan Ring Balance Meter. This versatile meter, with no external sealing chambers, is equally useful for flow measurements at low differential or high differential, at high or low pressures.

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The ring assembly is selected for each installation to assure ample power for accurate meter operation at all flows.

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Calibration, using dead weights, takes only a few minutes. It is not necessary to disconnect the meter from the line.

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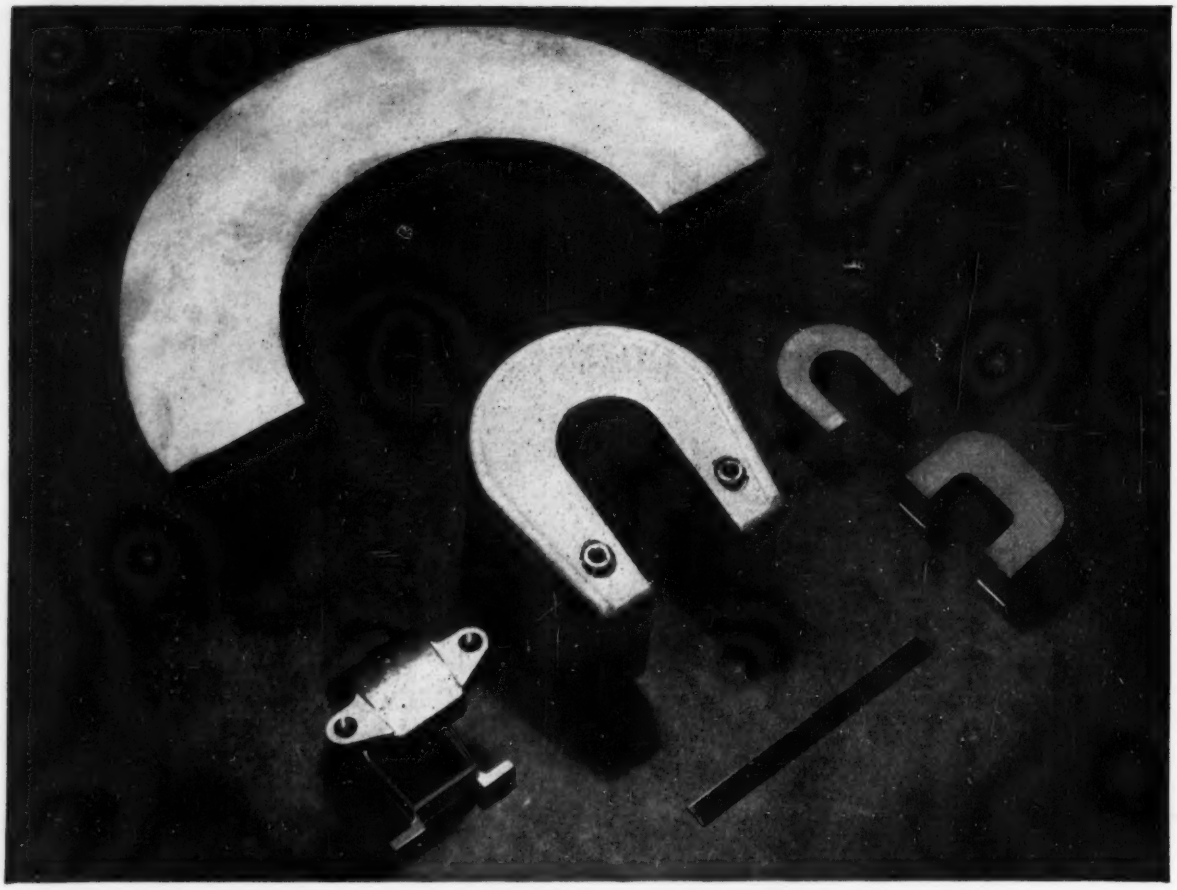

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For more information circle **10** on inquiry card. ⟶

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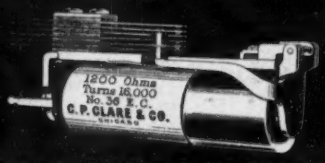
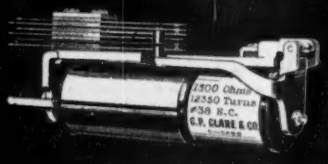


SLOW OPERATE—The Clare Type D Relay uses a low resistance copper slug to delay its operation. Operate time can be varied, from 0.01 to 0.1 second, by coil selection. Release time can be held low by heavy spring pressures and large residual settings.



SLOW RELEASE—The Clare Type E Relay uses a copper slug on the heel end of the coil to hold circuits operated from 0.05 to 0.3 second after the coil circuit has been broken. Operate time is from 0.01 to 0.04 second.

SLOW ACTING—The Clare Type H Relay uses dead-soft copper sleeve over coil core to delay buildup of magnetic flux so as to retard operation and release. Operate time may be from 0.01 to 0.05 second; and release time, from 0.03 to 0.3 second.

SNAP ACTION—The Clare Type CMS relay has enclosed snap-action switch contacts, rated at 10 amperes, 125 volts a-c

These five CLARE RELAYS have successfully met thousands of difficult applications

• CLARE RELAYS are built to render the utmost satisfaction to the user whose relay requirements are above the average—where extremely long life, and precise, reliable operation under severe conditions may be required.

Relays illustrated are all developments of the famous Clare Type C d-c Relay whose precision and dependability has been proved in thousands of military and industrial applications. They permit wide flexibility in design and construction to meet the most exacting requirements.

For full information on Clare relays, contact your nearest Clare sales engineer or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY

• *Write for Engineering Data Book*

FIRST **in the INDUSTRIAL FIELD**

CLARE RELAYS

FISHER® FACTORIES

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• Above—Factory No. 1. Over 255,000 sq. ft. of floor space. The industry's most modern plant. Here the world's largest production of pressure and liquid level control equipment is made possible by Fisher's unequalled research, design, engineering, testing and manufacturing facilities.

• At Left—Factory No. 2. Over 67,000 sq. ft. of floor space. A major unit in Fisher's continuing expansion program of increased facilities and production.

FISHER

PRESSURE REGULATORS

•

GAS REGULATORS

•

LIQUID LEVEL CONTROLLERS

•

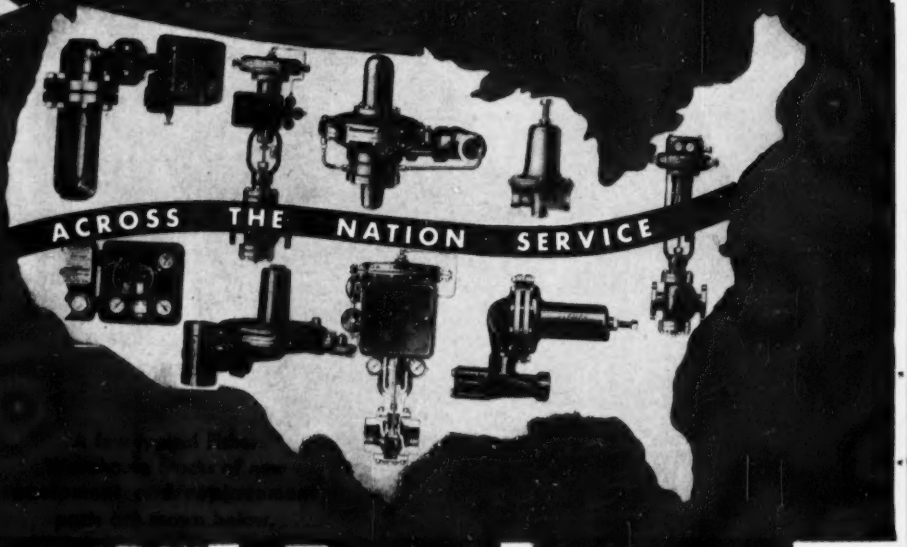
DIAPHRAGM CONTROL VALVES

•

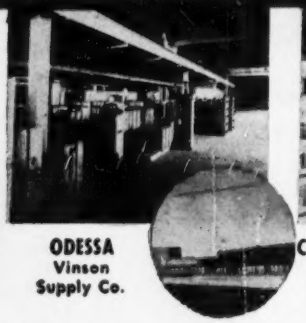
PUMP GOVERNORS

•

LEVER and FLOAT VALVES



LOS ANGELES
Carter-Jones Co.

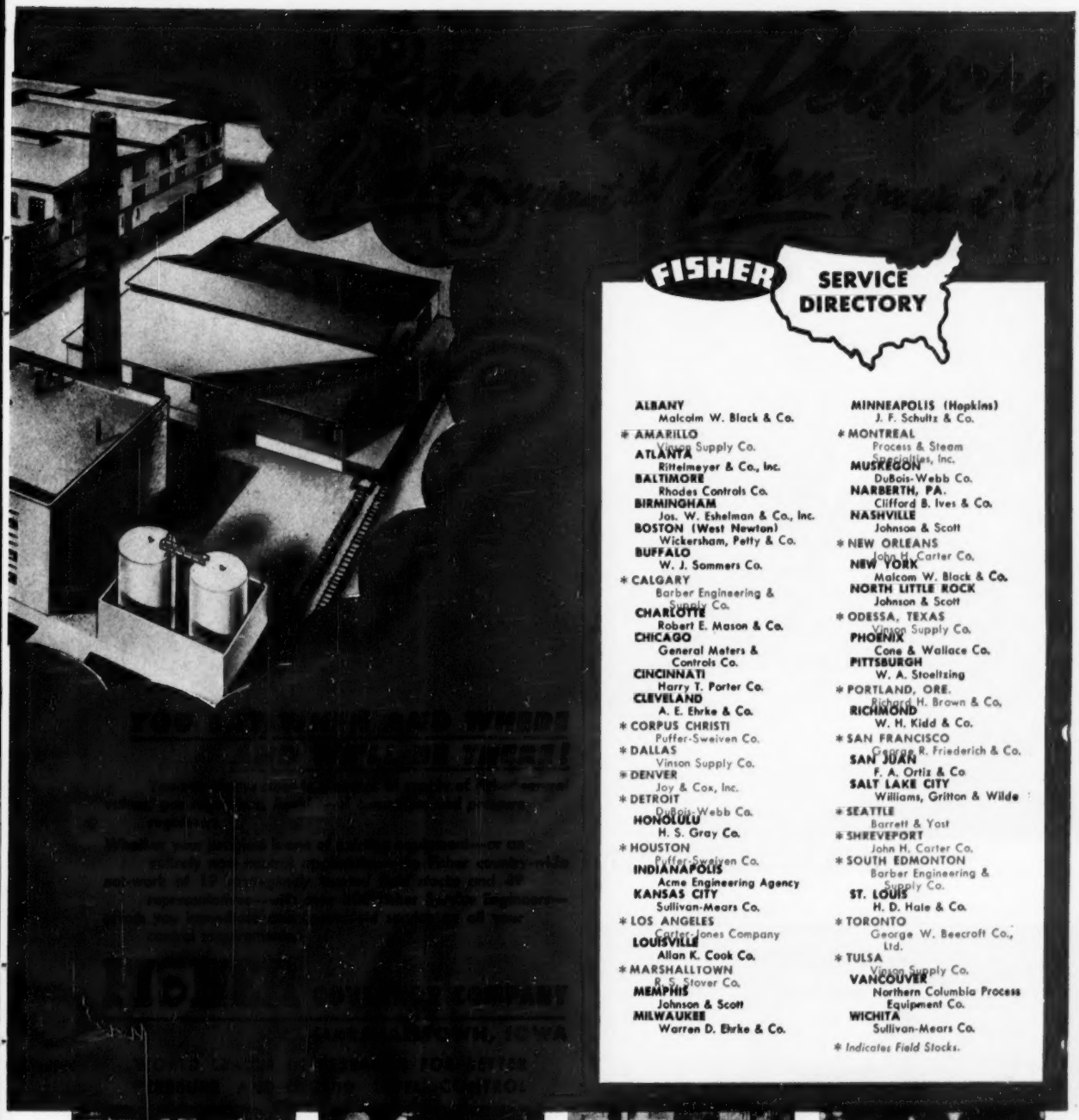


ODESSA
Vinson Supply Co.

CORPUS CHRISTI
Puffer-Sweiven Co.

For more information circle **11** on inquiry card.

AND FIELD STOCKS



FISHER SERVICE DIRECTORY

ALBANY
Malcolm W. Black & Co.
* **AMARILLO**
Vinson Supply Co.
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Rittelmeyer & Co., Inc.
BALTIMORE
Rhodes Controls Co.
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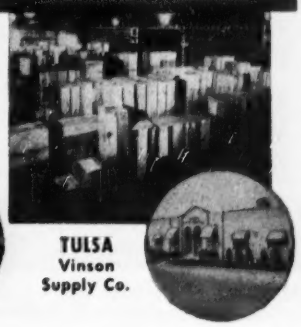
Vinson Supply Co.
VANCOUVER
Northern Columbia Process Equipment Co.
WICHITA
Sullivan-Mears Co.

* *Indicates Field Stocks.*

HOUSTON
Puffer-Sweiven Co.

NEW ORLEANS
John H. Carter Co.

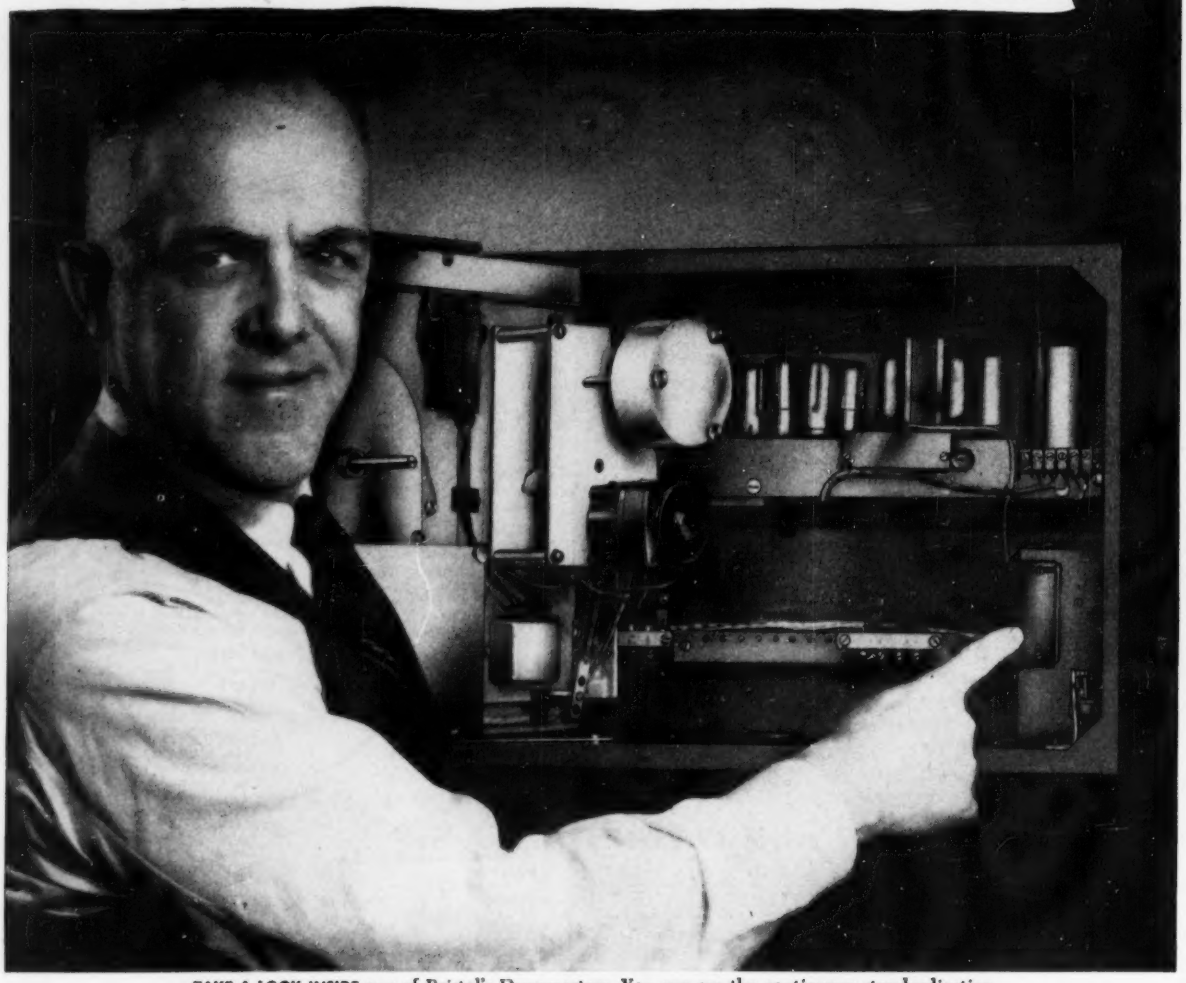
DALLAS
Vinson Supply Co.



TULSA
Vinson Supply Co.

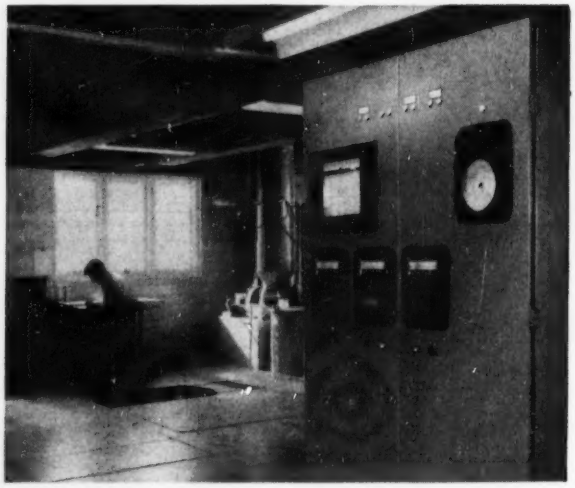
For more information circle **11** on inquiry card.

WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL



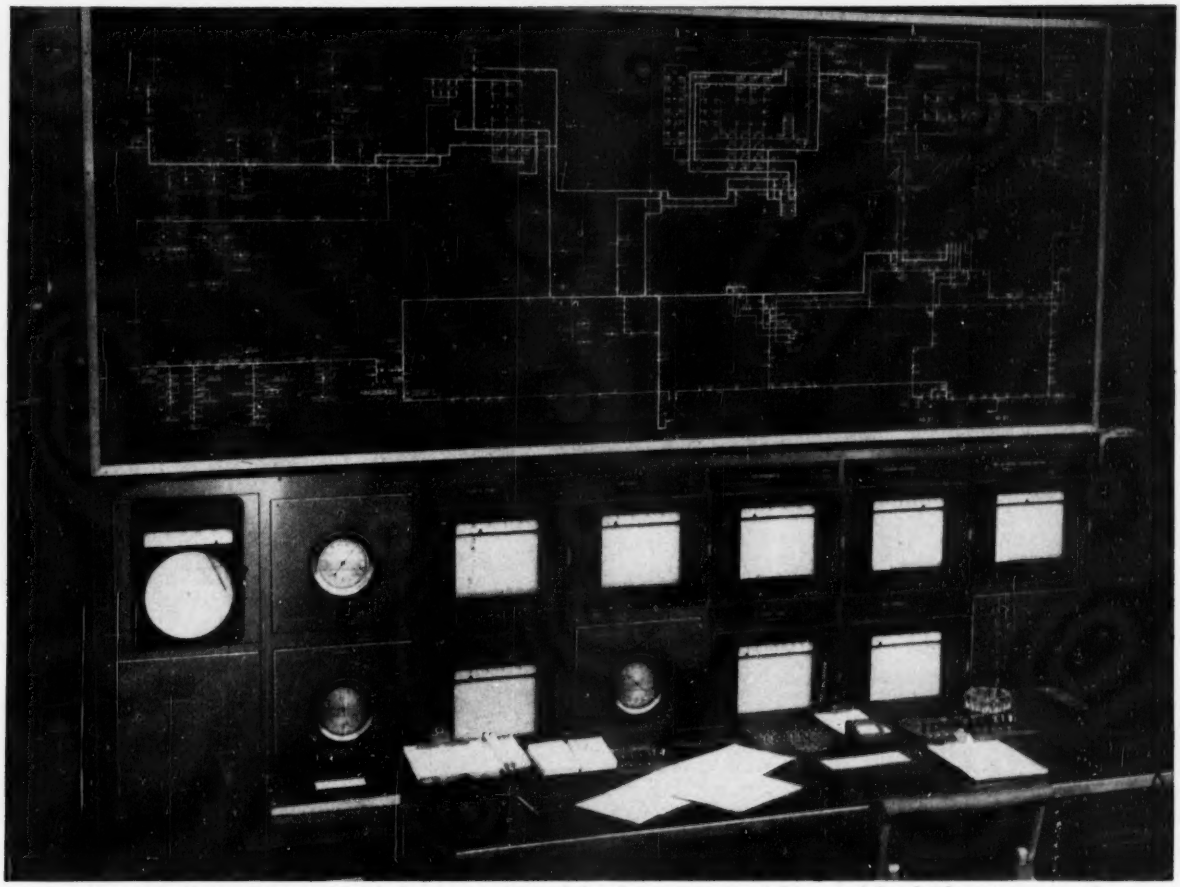
TAKE A LOOK INSIDE one of Bristol's Dynamasters. You can see the continuous standardization unit that eliminates need for dry cells and any interruptions in operation for standardization.

VISCOSITY of linoleum paste is continuously recorded by a Dynamaster Consistancy Recorder at large floor covering plant.



DYNAMASTER pH RECORDER and Bristol pH controllers guard purity of water supplied to large drug manufacturing plant.

For more information circle **12** on inquiry card.



GAS PRESSURES at strategic points in the gas transfer and distribution systems of the Consolidated Edison Company of New York are recorded by these easy-to-read Bristol Dynamaster Metameter receivers.

Measures any variable that can be translated into an electrical quantity

• Bristol's Dynamaster Potentiometers have earned a world-wide reputation for accuracy and dependability in recording, indicating and controlling temperature, pH, speed, voltage, power, current, resistance, smoke density, strain – the list could go on and on.

Behind this reputation is 65 years of instrument-making research and experience – all aimed at making Bristol instruments as precise and trouble-free as humanly possible.

One result of this research is our new No-Batt continuous standardization system, which is used in Dynamaster Potentiometers and Pyrometers. With continuous standardization eliminating the need for dry cells, the potentiometer is free to continuously measure, record and control. No time out is required for periodic standardization.

And all Dynamasters are "human-engineered", making them easier to read and clearly visible at greater distances. Simplified construction, fast operation, fewer moving parts are all achieved through Bristol's "human engineering".

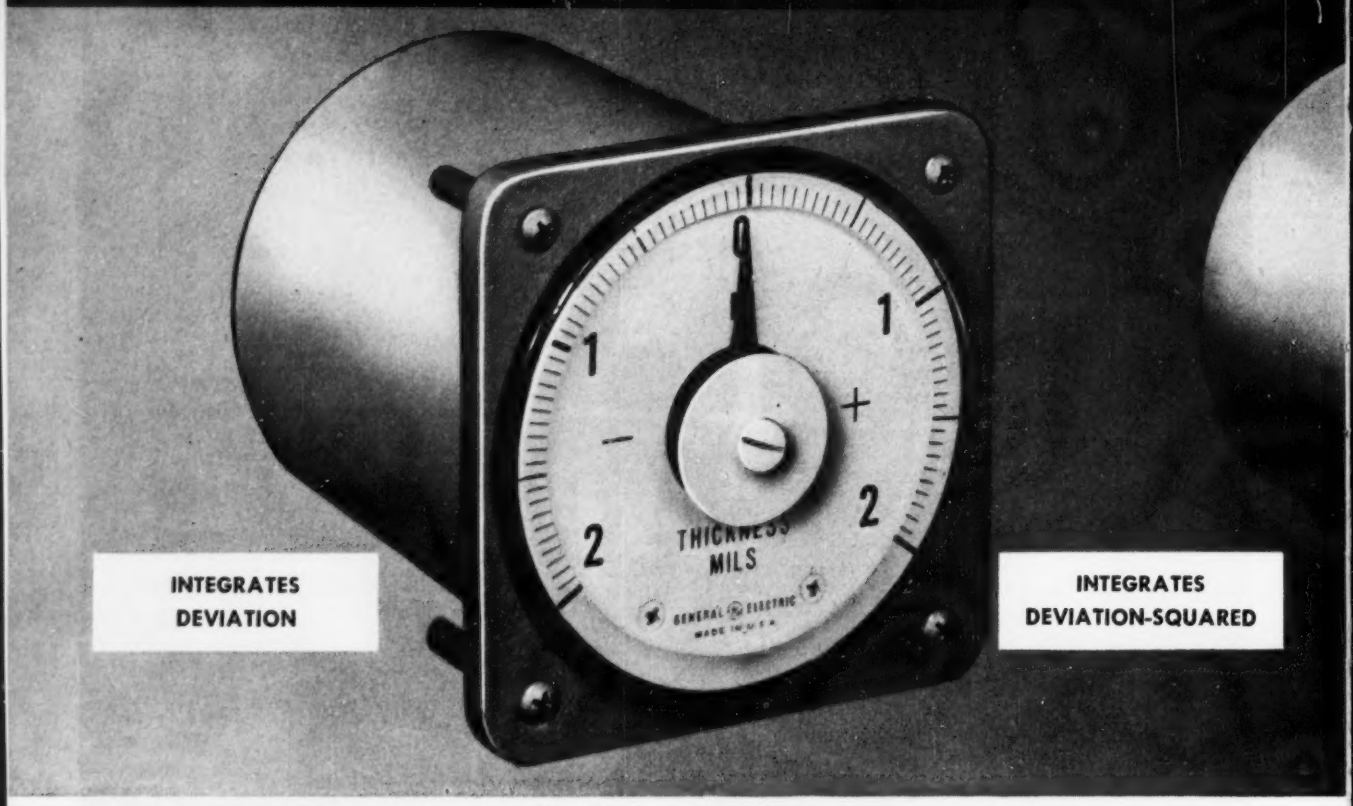
Get the whole story on these rugged, precision instruments. Write today for free 36-page bulletin P1245. The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut. 4.10

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **12** on inquiry card.

Developments in Instrumentation for Quality Control

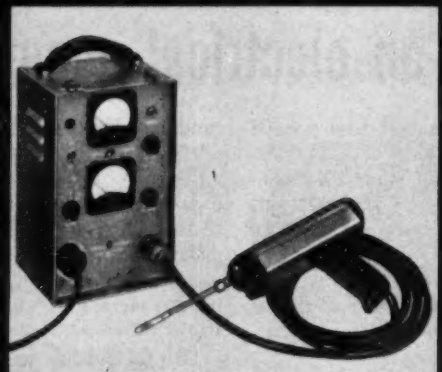


MEAN AND STANDARD DEVIATION of variables encountered in the quality-control analysis of continuously moving samples can now be readily and accurately determined. General Electric's two new direct-reading instruments, designed to do this, are the answer.

INTEGRATING DEVIATION AND DEVIATION-SQUARED, the instruments, used with suitable primary detector, reduce statistical analysis of variables to simple slide-rule calculation. Accuracy of about ±3% full scale is possible when integrating over a two-minute period.

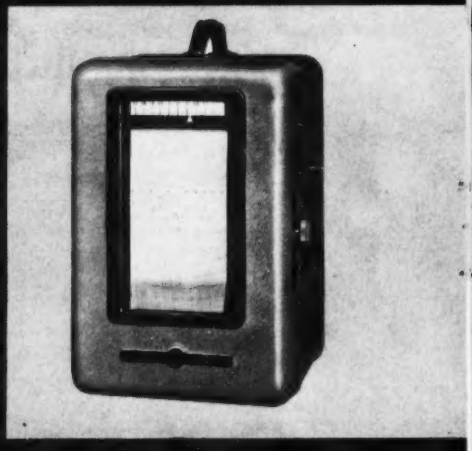
More News About General Electric Instruments for Improving Product Quality

LEAK DETECTOR



FOR LOCATING LEAKS in any closed system or tank containing a halogen gas, or in any system into which a tracer gas may be introduced; the leak detector will detect a leak of 1/100 ounce of Freon** a year. $604.50.*

PHOTOELECTRIC RECORDER



RECORDS RAPIDLY CHANGING PHENOMENA with a minimum load on measured circuit, the recorder is available with sensitivity as low as one microampere full scale. Response times as low as 1/5 second. $700.00.*

*Manufacturer's suggested retail price.
**Registered trade-mark, Kinetic Chemicals Div. of E. I. du Pont de Nemours & Co.

For more information circle **13** on inquiry card.

GENERAL ELECTRIC ANNOUNCES

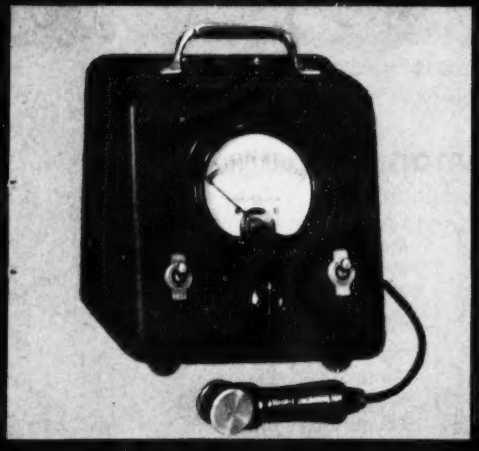
Two New Integrating Instruments

FOR BETTER QUALITY CONTROL

WIDELY APPLICABLE, the instruments are highly valuable in the manufacture of such products as textile yarns, strip metal, paper, wire, plastics, rope, and photo film. Measured variable could be thickness, width, diameter, density or any other deviating quality.

FOR FURTHER INFORMATION about these unique new time-saving instruments contact your nearest General Electric Apparatus Sales Office. For your copy of Bulletin GEC-1230, which describes the new instruments in further detail, simply check the coupon below.

THICKNESS GAGE



HIGH-POTENTIAL TESTER

SECTION B605-68
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Integrating Instruments (GEC-1230)
- ☐ Leak Detector (GEC-233)
- ☐ Photoelectric Recorder (GEA-5536)
- ☐ High-potential Tester (GEC-700)
- ☐ Thickness Gage (GEC-319)

Name.....

Company.....

Street.....

City..... Zone.... State.....

NON-DESTRUCTIVE THICKNESS TESTS of any non-magnetic material on a magnetic base are easily made with the G-E thickness gage. Ranges include from 0.0002 to 0.10 inch; special scales to 0.30 inch. $183.30.*

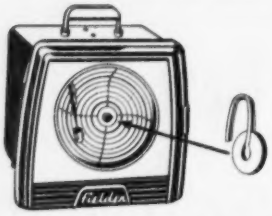
CURRENT-LIMITED to a maximum of 5 milliamperes, the G-E high-potential tester minimizes most of the hazards encountered with other such equipment. No barriers, cages or white tape are needed. $195.60.*

GENERAL ELECTRIC

For more information circle **13** on inquiry card.

News About Created-Metals

Thermistors Stabilize Circuit Resistance



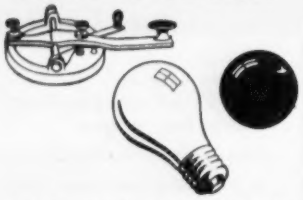
A Carboloy Thermistor improves the accuracy and sensitivity of the Tektolog Electronic Recorder.

Matching the negative temperature coefficient of a Thermistor and a low-resistance manganin shunt to the positive temperature coefficient of the copper coil results in a circuit of constant resistance within ±5% for ambient temperature from 32° F. to 150° F.

The high degree of compensation is achieved with a relatively low resistance and makes possible accurate recording of voltages as low as 20 millivolts full-scale.

For more information on Thermistors for temperature compensation and detection, warning devices and controls, write: Carboloy Department of General Electric Company, 11155 E. 8 Mile Street, Detroit 32, Michigan.

Many Uses Found for Cemented Carbides

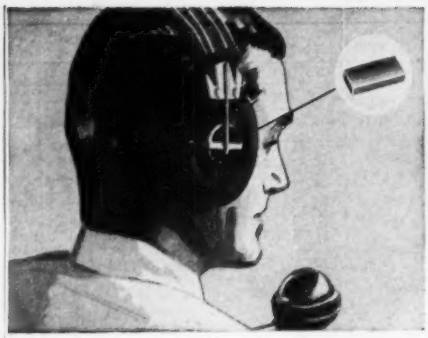


The electronics and electrical industries are cutting costs and improving products with wear-resistant cemented carbides.

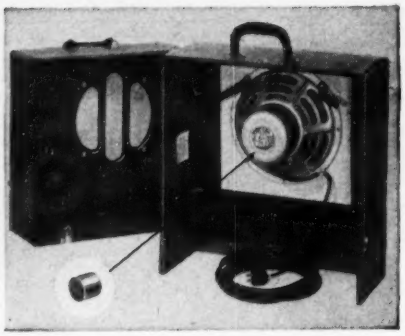
For example, tough grades of Carboloy cemented carbide are extending the life expectancy of telegraph relay contacts. Carbide-tipped tools are saving time and money in woodworking and cabinetry.

Carbide wire dies for making electric-light filaments and draw dies for making component parts far outlast steel dies. Bearings of chrome carbide are light, strong, nonmagnetic.

Industry is daily finding new uses for cemented carbides. The Carboloy Engineering Appraisal Service will help you put carbides to work in your plant. For more information, write: Carboloy Department of General Electric Company, 11155 E. 8 Mile Street, Detroit 32, Michigan.



Small size, light weight and permanent power are essential in military headsets. Carboloy Alnico 2 permanent magnets permit a thinner, lighter receiver with high output and level response.



Public-address loudspeakers utilize the acoustic action of powerful Carboloy permanent magnets. The uniformity and strength of these magnets help produce truer tone.

Permanent Magnets

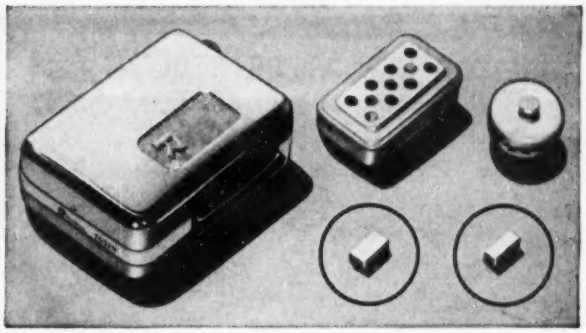
Two Carboloy cast Alnico 6 permanent magnets cut manufacturing costs in this new telephone built by Connecticut Telephone & Electric, Meriden, Conn. One magnet provides acoustic action for receiver; other magnet supplies generator action to operate bell ringer. The magnets' consistent field holds post-assembly adjustment to a minimum.

Basic functions of permanent magnets

1 Convert electrical energy to mechanical motion	Eddy current braking Motor action Instrument action Acoustic action Electron beam control
2 Convert mechanical motion to electrical energy	Generator action Magneto action Sound pick-up
3 Convert mechanical energy to thermal energy	Control of torque
4 Mechanical holding	Snap action Separation Holding and lifting

For more information circle 14 on inquiry card.

The heart of this Gibson electric guitar is the magnetic pick-up. Steel strings vibrate in the field set up by two small Carboloy permanent magnets, generating minute electrical impulses.



New all-magnetic, all-transistor hearing aid uses permanent magnets in both microphone and receiver. These tiny magnets eliminate hearing-aid failure caused by opera ional heat, and by humidity.

improve sound pick-up and acoustic action

They make possible simplified design, lower costs, and improved performance in communication devices and in many other important fields

Carboloy® Alnico permanent magnets are replacing electro-magnets in both the input and output elements of communication devices.

Because permanent magnets convert mechanical motion to electrical energy, they improve sound pick-up action for microphones and other transducers. And because they convert electrical energy back into mechanical motion, they provide the acoustic action necessary in telephone receivers and loudspeakers.

Carboloy permanent magnets supply a uniform source of stable, low-cost energy. By using power-packed permanent magnets, you'll eliminate coils, wires and other operating parts. Design is simplified; product size and manufacturing costs reduced.

Carboloy permanent magnets are available sintered, as well as cast. Sintered magnets hold closer tolerances, permit more complex shapes.

Perhaps Carboloy permanent magnets can improve your products or equipment. Specially trained engineers of the Carboloy Engineering Appraisal Service will work with you on permanent magnet design and application. Send coupon, today, for catalog or design manual.

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

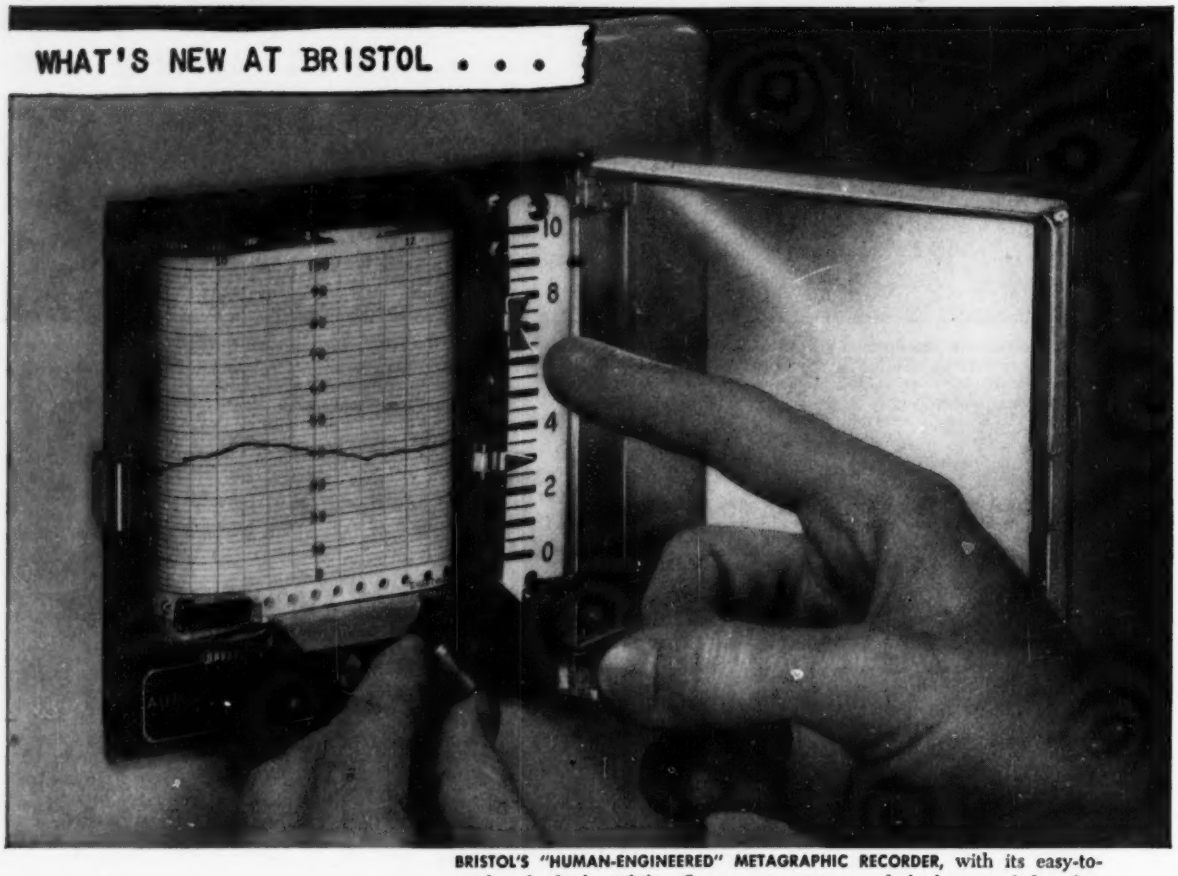
CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11155 E. 8 Mile Street, Detroit 32, Michigan

Send me the following without cost or obligation:

☐ Permanent Magnet Design Manual, PM-101
☐ Permanent Magnet Standard Stock Catalog, PM-100

Name_____ Position_____
Company_____
Address_____
City_____ Zone____ State_____

For more information circle **14** on inquiry card.



BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned the distinction of being the "biggest little instrument in the business."

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5" x 5½"). The answer is that the Bristol instruments have been "human-engineered", making them easy to read, and clearly visible at greater distances.

The air-operated METAGRAPHIC, which records pressure, temperature, vacuum, flow, differential pressure, and liquid level, offers these big advantages:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds. True plug-in service.

CONTINUOUS VALVE-POSITION INDICATION . . . on same instrument scale as set-point scale, gives continuous data on control valve position—makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

CONTINUOUS OPERATION . . . complete unit can be retracted for inking pen, and for set-point and zero adjustment without disturbing record or control.

Get the whole story on the "human-engineered" METAGRAPHICS – how they can help you get more accurate measurements, faster and easier. Write us today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

6.4.4R

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **15** on inquiry card.

Trends... Late News and Comments

Analog computers will find extensive application in industrial operations when industrial engineers learn the new techniques for simulating process operations. Techniques do not require advanced mathematics, but do require new terminology—transfer function, scale factor, initial conditions, integrate, differentiate, etc.

"Automation may bring about considerable decentralization of industry with groups of engineers and technicians working under what will be almost laboratory conditions," says R. C. Sollenberger, executive vice president, Conveyor Equipment Manufacturers' Association, in an address before the Society for Advancement of Management.

Research and development expenditures are being accelerated by American industry as competition for the customer's dollar increases, according to a report on 1953 sales figures released by SAMA (Scientific Apparatus Makers Association), which shows 9% increase for laboratory equipment.

As a result of forecasted higher demands for large industrial equipment, General Electric plans to build a new multi-million-dollar plant in Roanoke County, Va., announces C. A. Salmonsen, manager of the company's Industry Control Department.

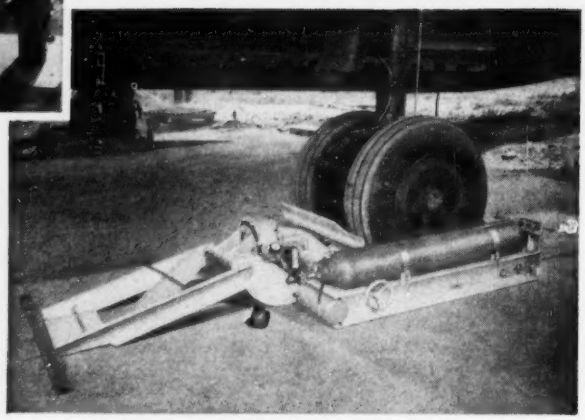
Privately-owned nuclear reactors for research at universities and industries will open new vistas. First private reactor is now in operation at North Carolina State College. AEC has approved fissionable material for a reactor at Pennsylvania State College. North American Aviation offers a catalog for prospective purchasers of reactors; the Babcock & Wilcox Co. also offers firm bids for construction and installation of private reactors.

Camera instrumentation is expanding. Recent techniques are extending versatility in many directions. Industrial problems are being investigated by use of cameras with frame speeds of 100,000 per second; each frame is exposed by use of microsecond-flash technique. Uses reported include loom and spinning machine analysis in textile industry, dial operation of telephones, and behavior of rocket engines, welding arcs, explosions.

"Industry must give more attention to modernization if it is to avoid destruction by obsolescence," says Ralph E. Cross of The Cross Co., Detroit. As modern machinery and processes are highly instrumented, percentage investment in instrumentation must increase.

Transistors are beginning to appear in commercial equipments. To date, hearing-aid industry has been the only one using transistors in quantity. However, transistors are now appearing in intercoms, power supplies, amplifiers, etc.

Automation of machine tools requires automatic work and tool positioning, plus continuous gaging at all times. Pneumatic and electronic techniques are being applied to the continuous gaging problem.



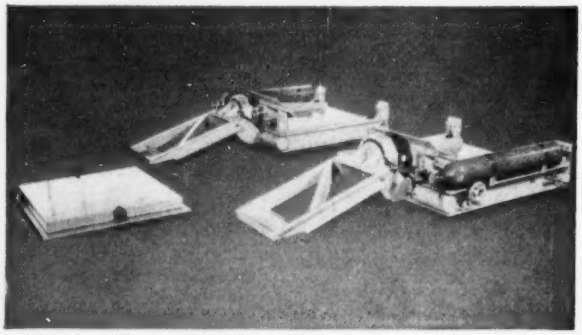
"GO" or "NO GO"

Thrust stands equipped with Hagan ThrusTorq units deliver direct, accurate readings of the actual performance of the plane engines under test. The pneumatic signals actuate indicators or recorders, either at the stand or remote, so that test personnel know instantly whether it is "go" or "no go" for the plane under test.

The portable stand, shown in the center and bottom photographs, requires only stop pieces bolted to the apron. The right and left wheel stands have their own supply of bottled nitrogen, used as a power source for the Hagan ThrusTorq. The stands can be set to suit the span of the landing gear. This stand measures a total thrust up to 25,000 pounds.

Maximum capacity is determined by the number and size of Hagan ThrusTorq units used in the assembly.

The Hagan ThrusTorq unit is fast, economical and clean. It is also used for thrust measurement of rocket and jet engines, and cradle dynamometer measurement of aircraft engines.



Complete Portable Thrust Stand, showing nose wheel unit and thrust measuring units in relative operating positions.

HAGAN
HALL
BUROMIN
CALGON

Hagan Corporation

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH 30, PA.

CONTROL SYSTEMS FOR AUTOMOTIVE AND AERONAUTICAL TESTING FACILITIES
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
BOILER COMBUSTION CONTROL SYSTEMS

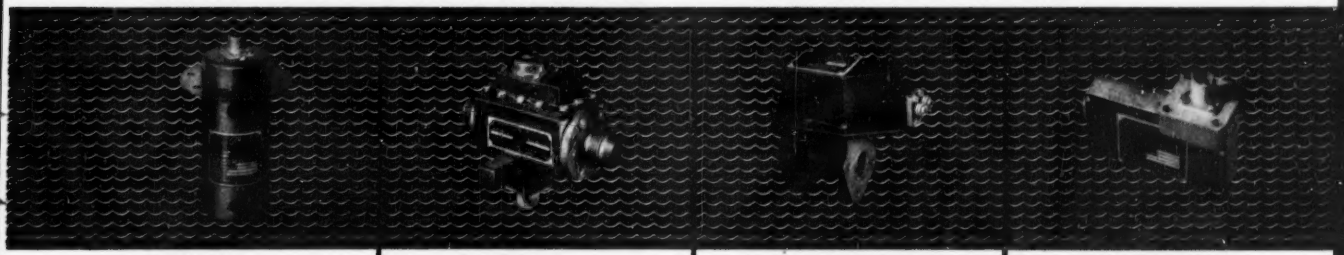
For more information circle **16** on inquiry card. Circle **17** on inquiry card. →

Revere INSTRUMENTS SEE WHERE YOU CAN'T

See *Revere* . . . if you need to know — **HOW MUCH LIQUID — HOW LITTLE — AT WHAT LEVEL.** *Revere's* precision made instruments are your unfailing eyes that see into sealed tanks, tubes or complex fuel lines. They can provide you with accurate measurement of liquid level regardless of pressure or temperature changes, vibration or rapid acceleration forces, AND they will automatically transmit a warning signal whenever liquid flow or level maintenance varies from a pre-determined value.

These hermetically sealed, magnetically actuated instruments employ balanced float assemblies to minimize false alarms. Compact and light, Revere instruments meet government specifications. They are available in many different configurations, some of which include relays to handle heavy electrical loads. Others are designed for complete submersion in fluids.

*Submit your control problem to our Field Engineering Department today. Revere will provide the instruments to tell you — **HOW MUCH — HOW LITTLE — AT WHAT LEVEL.** Shown below are some instruments that are the seeing-eyes of aircraft and industry.*



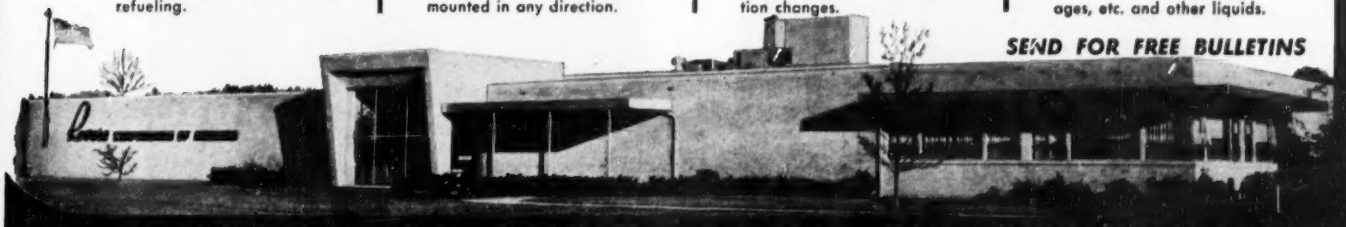
FLOAT SWITCH
Specially designed with single or dual float systems to provide automatic cut-off control for single point high pressure refueling.

FLOW SWITCH
Provides instantaneous warning signal whenever liquid flow falls below a pre-determined value. It can be mounted in any direction.

INDICATING SWITCH
Records the presence of fluid in a line whether stationary or flowing and transmits a warning signal if fluid condition changes.

FLUID LEVEL SWITCH
Used to maintain accurate high level, low level or constant level control of fuels, water-alcohol mixtures, beverages, etc. and other liquids.

SEND FOR FREE BULLETINS



REVERE CORPORATION OF AMERICA
WALLINGFORD 2, CONNECTICUT, U. S. A.
precision instruments for aircraft and industry

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Machine-tool Automation

FOND DU LAC, WIS.—A record-playback control which directs a machine or process cycle from information stored on a magnetic tape is being built by the General Electric Company's Specialty Control Department for the Giddings and Lewis Machine Tool Company, Fond du Lac, Wis.

The automatic control is expected to double the production speed of a milling machine.

In operation, a skilled machinist or tracer control runs the machine through a series of motions to produce the first piece of work. These motions are translated into electrical signals by means of Selsyns and are recorded on the magnetic tape through an electronic circuit. Non-productive motions such as tool setting, gaging, template changing, and stop settings are not recorded.

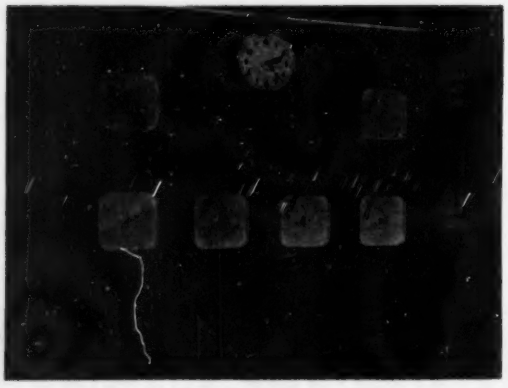
When the tape is played back through the machine it automatically duplicates the machine's original motions and produces a part identical to the one made while recording. Repeat orders can be produced economically merely by taking the specified tape recording from a file and inserting it into the control.

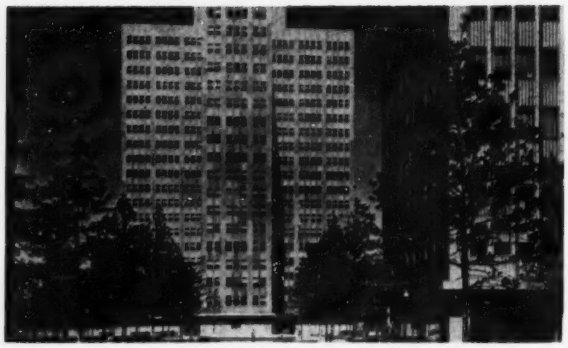
Ultrasonics Measures Viscosity

NEW YORK, N. Y.—Ultrasonics now improve manufacturing of sandpaper. According to a report from the Carborundum Company, ultrasonic waves, introduced into the adhesive mix, measure the sound-wave energy required to cause the layers of adhesive to slosh back and forth over one another. This energy is proportional to the viscosity of the mix. This is calculated by an electronic computer which feeds the data to a special electronic recording-controlling instrument, designed by Minneapolis-Honeywell engineers, which automatically maintains the viscosity of the fluid at the proper level.

Air-conditioning Instrumentation

PITTSBURGH, PA.—The Gateway Center buildings in downtown Pittsburgh, now nearing completion, are part of the greater Pittsburgh redevelopment project. As such, they are among the most modern office buildings in the world.





Comfort and working efficiency of office workers is assured through an extensive air-conditioning installation, which controls the temperature and humidity at optimum levels automatically, and provides clean air at all times through the use of an electronic precipitator. "Metameter" temperature and humidity transmitters, manufactured by The Bristol Company, Waterbury, Conn., send information from widely scattered check points in each building to a central panel board in the basement, where individual "Metameter" recorders provide a permanent record of temperature and humidity conditions night and day. In this way, building operators have a constant check on equipment functions, and at the same time are protected by conclusive evidence against possible tenant complaints of inadequate maintenance.

Titanium-trim Valve

PHILA., PA.—This huge titanium and silver diaphragm control valve, costing $10,000, was one of two recently designed and manufactured by Minneapolis-Honeywell's Valve

Users report on results with

Swartwout

AUTRONIC CONTROL SYSTEM

In just over 2 years since it was first introduced and caused such a sensation at the National Instrument Exhibit, Houston, the Autronic System has proven itself where proof counts—on stream—in plants in many parts of the country. For the Swartwout Autronic Control System is the *first system to control by all-electronic means—without boosters, slide wires or motors.* It senses . . . controls . . . indicates . . . records—faster and more accurately.

Reports like these keep coming in:

LARGE PROCESSING INSTALLATION—"In our plant, the Autronic Controller is located nearly a mile from the control valve. Its all-electronic operation has whipped the problem of process lags. And we're not troubled by leaking air lines. It has been in operation for one year and has been completely maintenance free."

PETROCHEMICAL PLANT—"Neatest, most compact installation on the graphic panel we've ever seen. Complete interchangeability of Autronic components without recalibration makes maintenance a cinch."

REFINERY—"We like the speed of response, reliability and general performance characteristics of our test installation. We figure on engineering the Autronic Control System into our new plant."

Call in our engineering representative to explain how the Swartwout Autronic Control System can bring new accuracy and speed to *your* process instrumentation and control. Or write today for literature on the *proven* Swartwout Autronic Control System.

A-8881

The following companies are representative of those who have purchased and who use Swartwout Autronic components:

American Cyanamid Company
Consolidated Chemical Industries Inc.
The Lummus Company
Minnesota Mining & Manufacturing Company
Sinclair Refining Company
Standard Oil Company (Indiana)
Universal Oil Products Company

Use of the above names is by permission but is not to be construed as constituting an unqualified endorsement.

Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle 18 on inquiry card.

AUTOMATIC SIM-PLY-TROL PYROMETER

(Thermocouple Type)

Flush Panelmount shown. Deduct $5.00 from price of cabinet models listed below.

Wall cabinet (not shown) 6⅛"x9½"x6⅛" Conduit knockouts on four sides and back.

Prices & Ranges

Temperature Range		Int. Res.	Ext. Res.	Thermo-couple*	Cat. No.	Price
0/3000° F.	0/1650° C.	70	10	Pt13%Rh	4538	$137.00
0/2500° F.	0/1370° C.	212	10	C/A	4531	132.00
0/2000° F.	0/1100° C.	172	10	C/A	4536	132.00
0/1500° F.	0/ 800° C.	179	10	I/C	4532	132.00
0/1000° F.	0/ 500° C.	112	10	I/C	4535	135.00
0/ 750° F.	0/ 400° C.	81	10	I/C	4534	137.00
0/ 500° F.	0/ 260° C.	52	10	I/C	4533	140.00
-75/ 225° F.	-60/110° C.	30	10	I/C	4537	145.00

Other ranges — Extra Charge

0/300° F.	0/150° C.	1500/3000° F.	800/1650°C.
-100/200° F.	-70/ 90° C.	1000/2000° F.	500/1100° C.
-200/100° F.	-130/ 40° C.	500/1500° F.	280/ 800° C.
-400/100° F.	-240/ 40° C.	450/ 850° F.	240/ 450° C.
200/ 700° F.	100/ 370° C.	350/ 750° F.	180/ 400° C.

*Most ranges can be calibrated for other thermocouples or higher external resistance. Prices do not include thermocouples.

LIMIT CONTROLS — Manual Reset

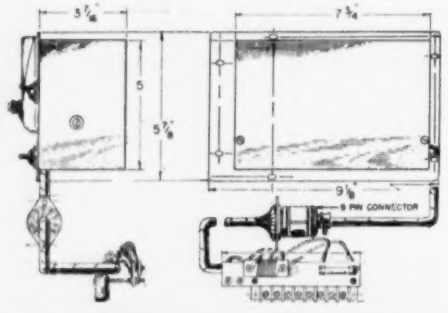
For safety shutoff or warning. Do not have automatic interrupter. Lock up and remain until reset.
HIGH LIMIT or LOW LIMIT, manual reset—deduct . . $15.00

LIMIT CONTROLS — Self Releasing

Safety shutoff or warning. Reset when the controlled condition is corrected. Provide pulsing action to the load relays. May be used for motor driven correction.
HIGH LIMIT or LOW LIMIT, self release—deduct . . . $10.00

DOUBLE CONTACT CONTROLS

DOUBLE CONTACT, manual reset—add $10.00
DOUBLE CONTACT, automatic reset—add $25.00
DOUBLE CONTACT, self release—add $15.00
DOUBLE CONTACT, interlocked—add $10.00
For controllable differential "on" and "off." Turn power off at high setting, on at low setting.



Assembly Products, Inc., Box 191,
CHAGRIN FALLS 10, OHIO phone: CH 7-7374

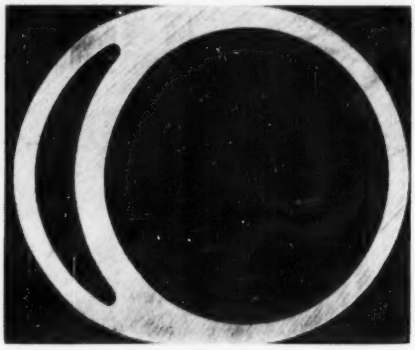
For more information circle 19 on inquiry card.

ON THE MARCH—CONTINUED

Division to handle high-pressure service of a highly corrosive fluid. The trim of this valve was machined from solid titanium. Under the severe operating conditions it will last 70 days before requiring replacing. The silver lining, or sleeve, 3/32's of an inch thick, was inserted in the inlet bore to give increased body life.

Steam-traced Piping

PITTSBURGH, PA.—Users of steam-traced piping have a totally new solution to their equipment problems in "Unitrace," an integrally extruded steam traced aluminum pipe manufactured by Aluminum Company of America, 720 Al-



coa Bldg., Pittsburgh. Extruded as a single unit from Alcoa 3S-F aluminum alloy, the new product is slightly oval in cross section because of the crescent-shaped steam passage adjacent to the product line. The size now available has the pipe dimensions of 2", Schedule 40 pipe. "Unitrace" exhibits improved heat transfer properties over normal steam-tracing techniques. Expense of steam jacketing and its installation is eliminated.

Welding Analyzer

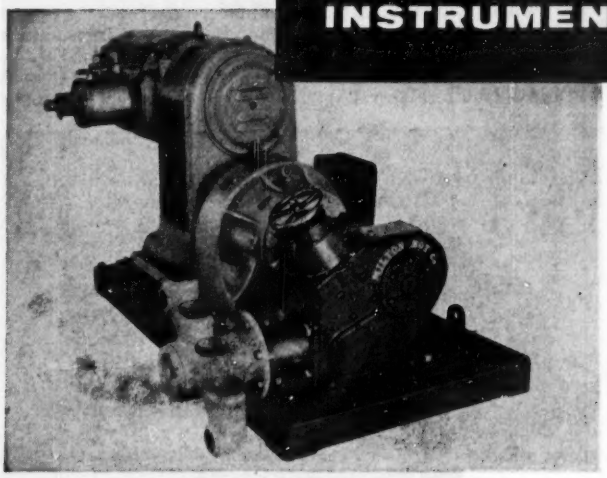
CHICAGO, ILL.—The Sciaky Brothers Company, Chicago, uses a Brush amplifier and oscillograph to measure welding

variables. The time relation, duration, and magnitude of current and force verify the welding-machine performance. The oscillograph writing element records even the small 180-cps. component in the 3-phase current.

Atomic-powered Locomotive

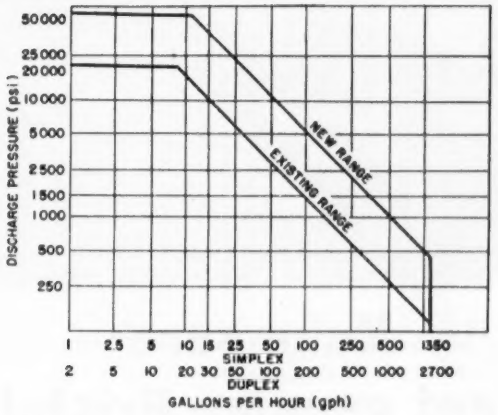
NEW YORK, N. Y.—The reactor for the proposed atomic powered locomotive, announced recently by the University of Utah, is already on the designing boards of The Babcock

CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS



This particular model is used for pressures up to 7500 pounds per square inch. A pneumatic piston positioner (top left) automatically regulates pumping speed in response to a 3-15 pounds per square inch instrument air signal.

Capacity and pressure range of the HyROYmetric Controlled Volume Pump compared with former capacity and pressure range of Milton Roy Pumps.



HERE'S THE NEW HYROYMETRIC®...

For Metering Accuracy at Higher Pressures and Capacities

Here's a new Milton Roy Flow-Control Instrument—to fill the growing industrial need for precision metering of liquids in the higher pressure ranges.

Capacity range:.....1 pint to 2700 gallons per hour

Maximum pressure:.....50,000 pounds per square inch

Capacity regulation:.....Manual or automatic and fully adjustable while in operation

Drive:.....Air or electric motor

Materials:.....Full alloy selection

The HyROYmetric is just one member of a complete line of Milton Roy Controlled Volume Pumps. Our engineering service includes sizing of equipment, proper instrumentation, panelboard design and construction, and all other details as part of the complete service available to you at no extra cost.

***Reference Literature*—Write for Bulletin 1153-A "HyROYmetric" and Bulletin 553 "Motor-Driven Controlled Volume Pumps."**

MILTON Roy COMPANY

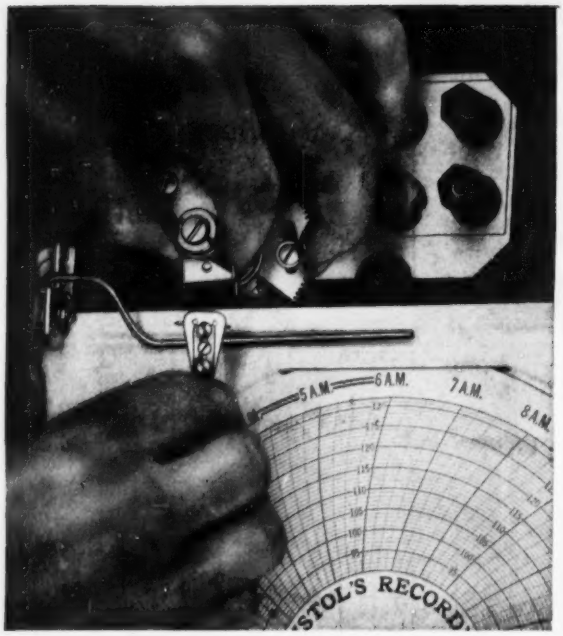
Manufacturing Engineers

1309 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

For more information circle **20** on inquiry card.



Make sure — get genuine Bristol replacement parts for your Bristol instrument

• Let's face it. The best instrument parts wear out. We make ours as accurate, as dependable and as long-lived as possible. But, eventually, some parts must be replaced. And when that time comes, it doesn't make sense to risk your original investment in a Bristol instrument by buying a doubtful replacement part.

All Bristol parts are designed, engineered and inspected to fit a specific instrument, to perform with complete accuracy even under the most rugged service conditions.

You wanted the best — and you got it, when you bought Bristol. So don't take chances when it comes to replacement parts. Only genuine Bristol parts are made to original Bristol blueprints; naturally they'll fit better and perform better — longer. Remember, Bristol knows Bristol best. Write to the Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

4.20

BRISTOL

Points the Way in Human-Engineered Instrumentation

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

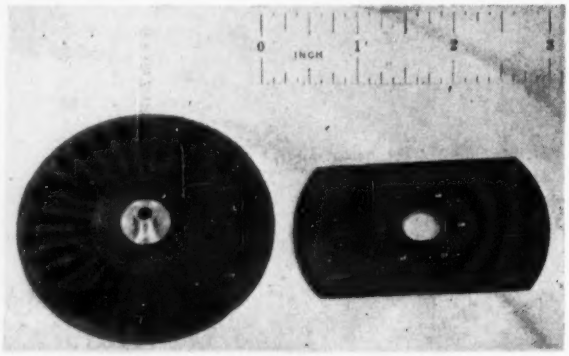
For more information circle **21** on inquiry card.

ON THE MARCH—CONTINUED

& Wilcox Company's Atomic Energy Division, 161 E. 42 St., N. Y. The reactor employs fluid rather than solid fuel.

Miniature Electrostatic Generator

WASHINGTON, D. C.—A miniature electrostatic source of high voltage for use with radiation survey instruments has been developed by S. R. Gilford, S. Saito, and J. L. Herson of the National Bureau of Standards. Many instruments require high-voltage sources of low current to supply



polarization potentials for ionization chambers. Conventionally this voltage is obtained from miniature high-voltage batteries, from a vacuum-tube oscillator in combination with a high-ratio transformer and rectifier, or from a vibrator power supply. The NBS generator is simpler to fabricate, is potentially less expensive, has fewer components, and avoids the use of special batteries.

The generator consists basically of a stator of two field plate conductors, and a rotor with a number of pairs of conducting sectors. Printed circuit techniques are used to apply the conducting areas to the flat insulating plates of the rotor and stator. Several sets of brushes transfer electrical charge between the components of the system and the storage capacitor. The attached driving system enables the rotor to be driven at speeds as high as 6000 rpm. by a reciprocating drive mechanism operated by an external lever. The generator can charge a 0.02-mfd. capacitor to 2000 volts in about 15 seconds.

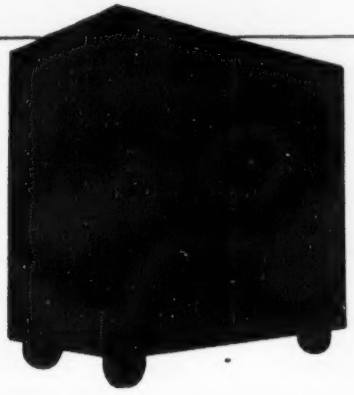
Finding Oil with Atoms

NEW YORK, N. Y.—Until recently, oil prospectors have relied on seismic-reflection, magnetometer, and gravity-meter techniques for oil prospecting. These techniques do

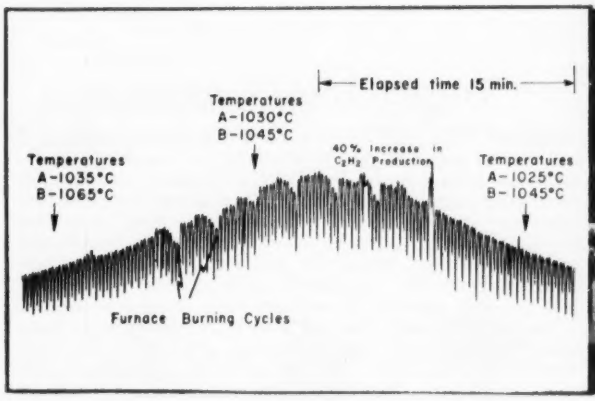
New acetylene production process uses the

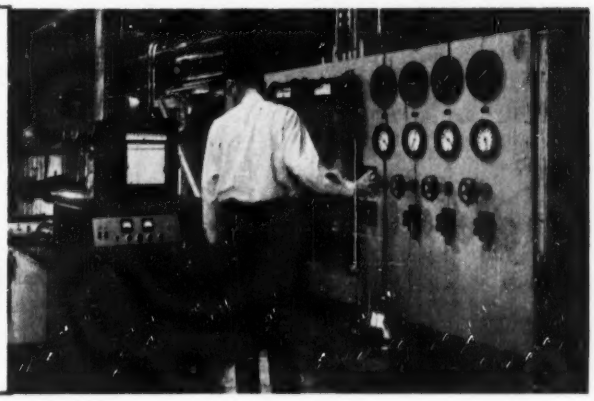
Consolidated continuous process–monitoring mass spectrometer..... for "on the spot" control

The new Consolidated Model 21-610 continuous process monitoring mass spectrometer played a part in the development of the Wulff Process for the commercial production of acetylene. Requiring only 110 volts and a small quantity of cooling water for operation, this self-contained, completely portable instrument was placed on stream in the pilot plant, where it monitored various gas streams under a variety of imposed conditions. Samples from 19 different points, introduced through a common manifold for analysis, made possible among other things: (1) the monitoring of feed stock, (2) evaluation of cracking gas composition versus temperature, (3) determination of fuel gas composition, (4) measurement of acetylene or ethylene content in recycle gas, (5) diacetylene scrubber efficiency, (6) acetylene or ethylene absorber efficiency, (7) solvent recovery and/or loss, (8) final product purity.



The chart, below, left, illustrates the versatility and practical value of the Model 21-610 as a production control instrument. The mass-26 peak of acetylene was monitored in the cracking gas coming directly from the unit as the furnace temperature was varied. From right to left, the temperature was slowly increased. The rise in the cyclically scanned 26 peak indicates rising acetylene content of feed stock. This test showed that acetylene increased approximately 40% with a temperature rise of 5 degrees C. Using the chart as a reference, guesswork was eliminated and maximum future production assured. Write for Bulletin CEC-1824-X16.





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Sales and Service through **CEC INSTRUMENTS, INC.** *a subsidiary with offices in: Pasadena, Atlanta, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

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EXACT WEIGHT Scales

Give Accurate Readings FAST

. . . and there's a type and size for every weighing need!

EXACT WEIGHT Scales clip seconds off each weighing operation. Short lever fall plus the action of an adjustable damping device bring scale indicator to rest quickly. Fractional-ounce visible indication enables operator to make an accurate reading at a glance. EXACT WEIGHT Scales weigh accurately in out-of-level position, adding to their flexibility of use. Model 213, shown, has a capacity of three pounds. There are other models with capacities and sensitivities to fit your requirements exactly. Send coupon for details.

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Better quality control
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Send complete information on End-tower Scales

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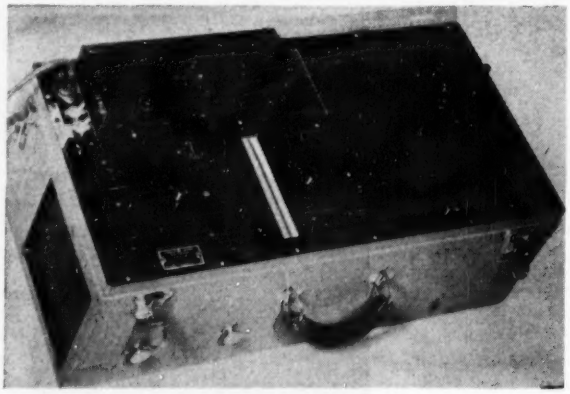
For more information circle **23** on inquiry card.

locate promising underground formations—but there may be no oil in a trap. However, it has been discovered that the intensity of nucleonic radiation above oil deposits is less than elsewhere around the pool. Hence, if you see a helicopter hovering near the ground, with a passenger dangling an instrument below the fuselage, you will know that the instrument is a Geiger or scintillation counter—and that oil prospecting is being made. A pioneer in geonuclear work is the Radiac Co., New York, N. Y.

Locomotive Oscillograph

SCHENECTADY, N. Y.—A special oscillograph has been developed by General Electric of Schenectady for testing locomotives. The special features required were (1) portability, (2) simplicity of use for locomotive engineers, (3) size to fit locomotive aisles, (4) stable circuits, and (5) safe



use to 1000 volts. The oscillograph uses six light-beam galvanometers; a seventh provides a 60-cycle timing signal. The record is obtained on 6-inch photographic film paper, which can be driven at 1, 3, 6, or 12 inches per second. As a 115-volt 60-cycle source is required, portable inverters are required.

Use has shown that locomotive engineers can operate the oscillograph, requiring only the services of a local photographer for developing records. Several problems have been solved while the locomotive has been in revenue service, without interfering with the schedule of operation.

Tagged Blast Furnaces

DEARBORN, MICH.—One of the largest quantities of radioactive material ever involved in an industrial experiment has been used by Ford Motor Company to trace the flow of iron ore through the white-hot heart of a blast furnace. Seventy-six tons of radioactively "tagged" ore were fed into the "Benson Ford" blast furnace at the Ford Rouge plant in Dearborn, Mich. The test was conducted to determine the feasibility of using as part of the "charge" fine iron powders obtained by concentrating low-grade ore.

The steel industry has assumed it is necessary to form these powders into lumps because the powders are too light to withstand the draft of a blast furnace long enough to be smelted into iron. It was the first time radioactive tracers were used to test the need for this extra step in iron making.

Ford research men reported that while the tests showed a "surprisingly" large amount of the fine iron ore particles, about 60 percent, was retained during the smelting process, this was somewhat too low to make charging of such powders practicable.

A five-pound lot of powdered iron ore concentrate was welded inside an aluminum container and sent to the AEC

to follow the leader – *precisely* – specify

Doelcam

Synchros

PERFECTION of detail is the difference between a good performance and the very finest — like the coordinated attack and release of a brilliant string section. The precision with which DOELCAM Synchros transmit and receive electrical information is unsurpassed in a precision industry.

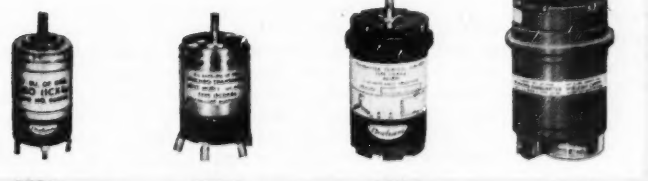
DOELCAM Synchros are tested and perfected standard military components for use in servomechanisms, computers, and automatic control systems. Many thousands have been delivered under Prime Government Contracts, which until recently absorbed our entire output. Now, the added facilities of our new plant enable us to make these outstandingly precise units available for general military and industrial usage. Your inquiry is invited.

Write for Bulletin S-4.

SIZES and Excitation	TYPES Control Transmitters	TYPES Control Transformers	TYPES Torque Transmitters	TYPES Torque Receivers
SIZE 11 1.062" O.D. 115v 400 Cycles	11CX4a	11CT4a		
SIZE 15 1.437" O.D. 115v 400 Cycles	15CX4a 15CDX4a	15CT4a	15TDX4a	15TR4a
SIZE 23* 2.25" O.D. 115v 60 & 400 Cycles	23CX4a 23CX6 23CDX4a	23CT4a 23CT6 23CT6a	23TX4a	23TR4a 23TR6 23TR6a
SIZE 31 3.10" O.D. 115v 60 Cycles			31TX6	

*All Type 23 Synchros are available with keyed or splined shafts.

Doelcam-designed Torque Receiver Error Tester has established an entirely new quality level for Type "TR" Synchros



SIZE 11 1.062" O.D. Specification MIL-S-16892 (BuOrd)

SIZE 15 1.437" O.D. Specification MIL-S-16892 (BuOrd)

SIZE 23 2.25" O.D. MIL-S-12472 (ORD) FXS-1066 (ORD)

SIZE 31 3.10" O.D. Specification MIL-S-12472 (ORD)

Doelcam CORPORATION

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West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

Gyroscopic Instrumentation • Servomechanisms
Synchros • Microsyns • Servo Motors

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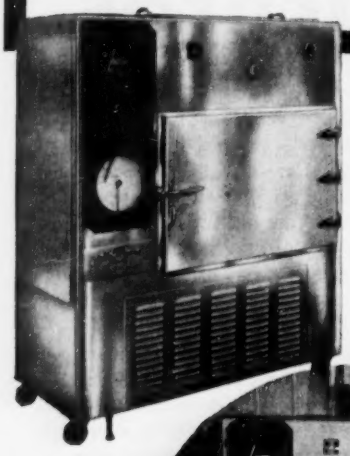
FOR PRECISE AND RELIABLE ENVIRONMENTAL TESTS

CLIMATE-LAB

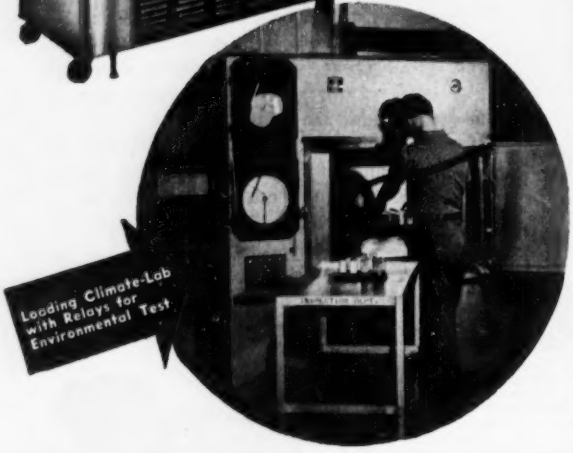
Humidity-Temperature TEST APPARATUS With Program Control



Widely used by industry and government for producing conditions required by U.S. Armed Forces for acceptance testing in accordance with various program schedules.

•

Equally adaptable to atmospheric corrosion studies, development and quality control.



Loading Climate-Lab with Relays for Environmental Test

The Climate-Lab is ideal for testing the performance and durability of materials and devices under specific climatic conditions. It consists of a test chamber, air-conditioning unit, and control system, all embodied in a compact unit which affords precisely controlled variations of humidity and temperature repeated periodically according to predetermined programs, and provides a chart record of these variations.

FOUR TYPES OF HUMIDITY-TEMPERATURE CONTROL

1. Constant humidity and constant dry-bulb temperature.
2. Constant humidity and varying dry-bulb temperature.
3. Varying humidity and constant dry-bulb temperature.
4. Varying humidity and varying dry-bulb temperature.

Write for Bulletin 2242-H

AMINCO Laboratory Instruments

AMERICAN INSTRUMENT COMPANY, INC.

Silver Spring, Maryland • In Metropolitan Washington, D C

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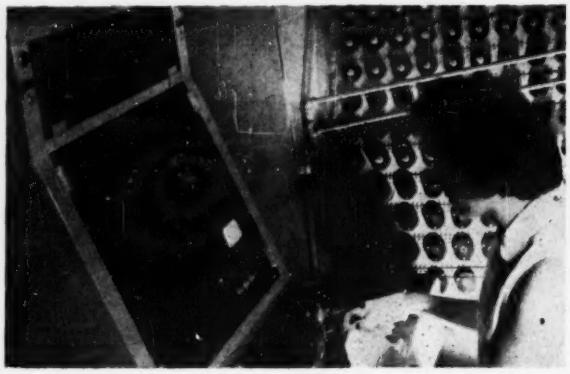
ON THE MARCH—CONTINUED

at Oak Ridge, Tenn. There, it was bombarded with neutron rays for eight days in a "nuclear reaction pile," then blended in giant cement mixers with 22 tons of identical iron ore powder. Finally, 54 tons of a second type of iron ore were added to obtain the mixture fed into the furnace. This research might eventually point the way to a better method of using low-grade ore concentrates.

Automatic Tube Test

EMPORIUM, PA.—An automatic test set, capable of handling up to 1,000 tubes per hour, has recently been developed by the Commercial Engineering Laboratory of



Sylvania Electric Products, Emporium. The test cycle is initiated automatically when the tube is inserted into the test socket. The test cycle proceeds automatically, and if a reject should occur, the cycle is stopped at the reject test, and a red light indicates that the tube is not acceptable.

Order Your Reactor

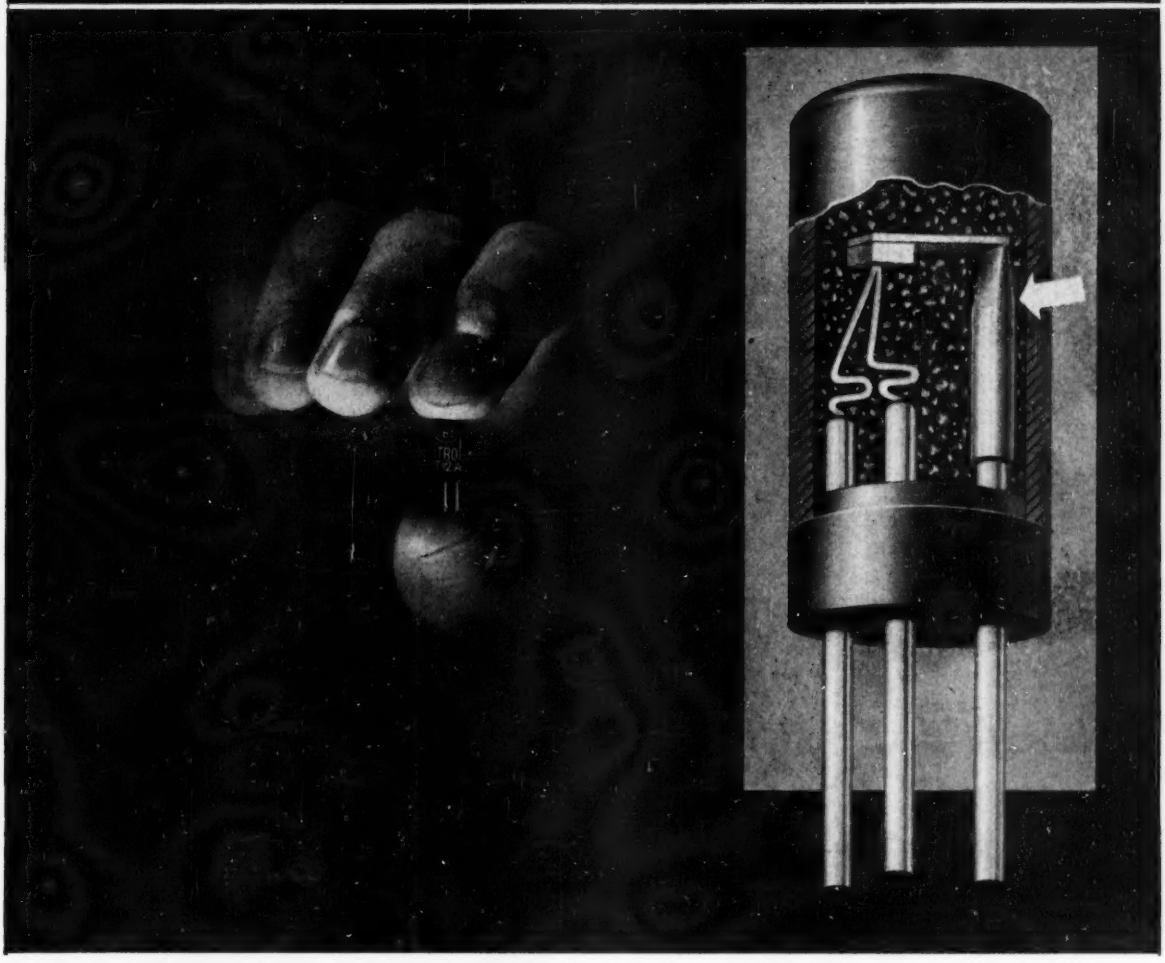
LOS ANGELES, CALIF.—The first atomic energy "catalog" in the nuclear field has been released by North American Aviation, listing research reactors the company is prepared to design and build for qualified scientific and industrial groups. Three basic types of reactors are described in the catalog, called "Nuclear Reactors for Science and Industry." These are the solution, pool, and homogeneous graphite types which can be used as the basis for reactor designs to meet specialized nuclear research requirements.

Metal Ultrasonic Delay Lines

WASHINGTON, D. C.—A delay line is a device for slowing down or storing a signal in an electric circuit. At radio frequencies this can be done by transforming the electric signal into a much slower sound signal and propagating it through an appropriate medium. After a given length of time the sound signal is converted to an electrical signal again. Delay lines are employed in radar, computers, and many new ordnance devices.

Up to the present time quartz, mercury, water, and certain magnesium alloys have exhibited some of the qualities needed for use in ultrasonic delay lines. Quartz and mercury have been used fairly extensively in certain applications, but quartz is expensive and hard to shape, while mercury is thermally unstable and is susceptible to mechanical shock, leakage, aging, and contamination. Mercury has been used, however, in the long delay lines of the NBS Eastern Automatic Computer (SEAC). In some devices it is desirable to use a material that will transmit 10-megacycle pulses, without appreciable attenuation or distortion of the signal, and give a 50-microsecond time delay. At the same time the material must be thermally stable and be easily

Transistors use Tubing...can you?



Something has happened in electronics of importance to you in more ways than one.

It's a tiny device called the Transistor—successor, enthusiasts say, to some vacuum tubes.

The one above, made by CBS-Hytron, a division of Columbia Broadcasting System, Inc., is no larger than your little finger nail.

You'll soon be listening to or looking at transistorized radio and TV—or saving space, weight and power with transistors in other equipment, such as telephones, calculators or computers. Then the materials in a transistor will be of top importance to you.

Each CBS-Hytron transistor contains a gnat-sized bracket made possible by using the good welding, soldering and formability properties of seamless nickel tubing.

Whether you need one foot of tubing for a trial balloon or one million feet for production, let Superior people and Superior's 55 analyses help you. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Round and Shaped Tubing Available in Carbon, Alloy, and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium.

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West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

All analyses .010" to ⅛" O.D.
Certain analyses in Light Walls up to 2½"

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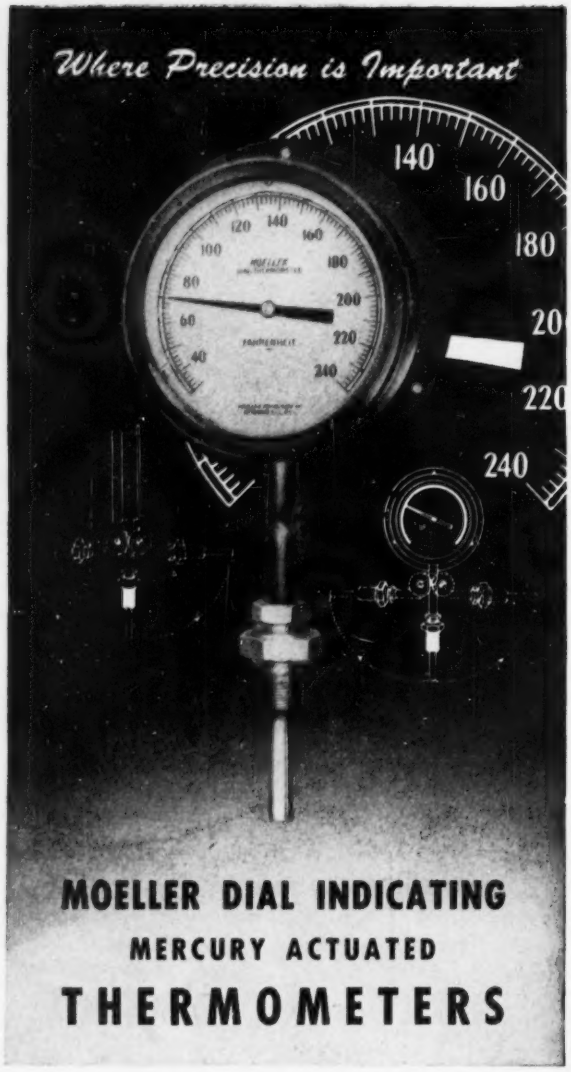

... come up with the right reading every time! Proper design plus 86 years of sound workmanship stand proudly behind these instruments.

The adjustable form feature, first introduced by Moeller—permits the dial to be set at any advantageous angle during installation. Easy to read and accurate.

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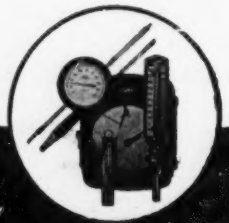

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INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

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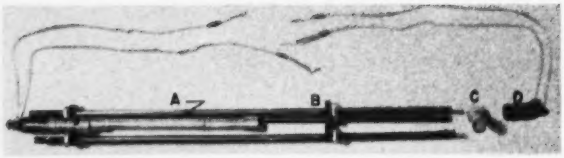


shaped into specific dimensions. No delay lines developed so far have all these qualities.

The National Bureau of Standards recently completed an investigation of metal ultrasonic delay lines for application in electronic computers and ordnance devices. The study disclosed that use of "Iso-Elastic"* alloys containing combinations of iron, nickel, chromium, and other minor elements may solve one of the primary problems in this field—finding materials that yield a thermally stable delay line.

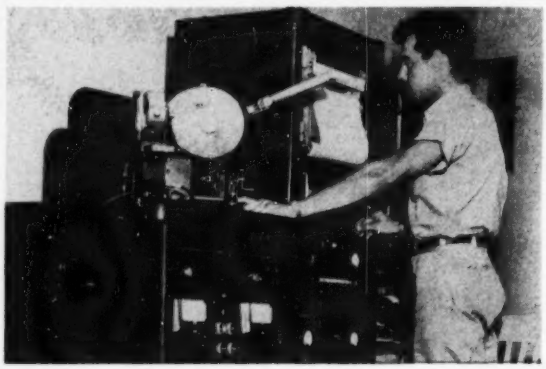
"Iso-Elastic" alloys are ones which have a constant modulus of elasticity with respect to temperature changes. Their primary use to date has been in watch springs and instrument applications. Since one of the requirements for ordnance delay lines is ability to give constant signal delay regardless of temperature changes, only the "Iso-Elastic" alloys and relatively few other materials can be considered for such a use. Two "Iso-Elastic" alloys were found (alloys of iron with 36-percent nickel and 8-percent chromium) with constant delay times from minus 50 to plus 170 deg. C.

Illustration shows a delay line (A) under test. Magnesium alloy buffer (C) has cement-attached crystal.

*Tradename, John Chatillon & Sons.

Clay Analysis

HOUSTON, TEXAS.—G. W. Brandt, Laboratory Technician, Baroid Sales Division, National Lead Company, Hous-



ton, adjusts controls on a Norelco X-ray Diffractometer prior to running a chart on a specimen. Problems in the Baroid X-ray Laboratory involve clays, oil-well drill-core specimens, bentonites, and special products. Films give X-ray patterns of essentially one-dimensional crystals.

Cell Study Technique

CLIFTON, N. J.—An electronic technique for measuring the microscopic constituents of living cells was disclosed jointly by Western Reserve University School of Medicine and Allen B. Du Mont Laboratories, Inc., Clifton, N. J. The method employs a standard television camera, a microscope, a cathode-ray oscillograph, a television receiver or monitor, and auxiliary electronic equipment to study the comparative absorption of substances such as dyes by normal and abnormal cells.

Tissues to be studied are specially illuminated in the living animal or, as done by other investigators, are prepared on slides, magnified by the microscope, picked up by the television camera, and transferred to the cathode-ray oscillograph. The technique has the possibility of study of chemical changes instantaneously as they go on in the living cell.

silicon

ACTUAL SIZE

Now . . . long-awaited *silicon junction diodes* are available; developed by Texas Instruments, a leading transistor manufacturer. Operating temperatures up to 150°C are safe, offering a new degree of design freedom!

junction

New . . . extremely low back current characteristics, as low as 0.001 microamps at rated voltage. Glass-to-metal hermetic seals, of course. For more detailed information on these new silicon junction diodes — and on other new TI semiconductor products — write today.

diodes!

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6000 LEMMON AVENUE DALLAS 9, TEXAS

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Here's why it pays to know your HSM

HONEYWELL SUPPLIES MAN

J. F. KRAMER, HSM (Honeywell Supplies Man) in the Cleveland area, points out features of the Brown Thermocouple Head to Al Shuba, Instrument Repair Group Leader at Jack & Heintz Inc. . . . shows how the all-weather design prevents corrosion, freezing and rusting.

Personalized, expert service . . . by full-time specialists in pyrometer supplies . . . is the keynote of the HSM Plan. This unique plan can bring new economy, convenience and quality standards to all your purchasing of pyrometer supplies.

Your nearby HSM will be glad to discuss how planned buying—the HSM way—can save time and money for you. He'll draw up an individually fitted program for your specific needs. Call him today . . . at the Honeywell office nearest you.

MINNEAPOLIS-HONEYWELL REGULATOR Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:**
Write for Pyrometer Supplies Buyers' Guide No. 100-5.

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BROWN INSTRUMENTS
First in Controls

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a teaspoonful of steam!

HERE'S THE ANSWER TO YOUR SMALL FLOW CONTROL PROBLEMS

a NEW LESLIE REDUCING VALVE

for accurate, foolproof regulation of small flows of steam, air, gas or liquids, with inlet pressures to 1000 psi and reduced pressures from 2 to 400 psi.

Change operating conditions quickly and easily with simple, handwheel adjustment —no need to waste time changing springs or swapping parts. Check these widely accepted Leslie features that are standard in the new, efficient, Leslie Small Flow Reducing Valve.

Check these features

- ✓ Simple, compact construction
- ✓ Top quality materials
- ✓ Metal Diaphragm
- ✓ Entirely enclosed—no stuffing boxes
- ✓ Corrosion resistant springs
- ✓ Hardened stainless steel valve
- ✓ Interchangeable inner valves

SEND FOR DESCRIPTIVE BULLETIN 511-A WITH *COMPLETE* CAPACITY TABLES

Before you order—

The new Class LCB is just one of the many units that are ***special*** with most manufacturers but are ***standard*** with Leslie.

Check to see if any pressure, temperature or level control you want is standard with Leslie, before you order. Play it safe. Your Leslie Engineer is listed under "Valves" or "Regulators" in the classified telephone directory in principal cities.

TRADE LESLIE MARK

THE FIRST NAME IN PRESSURE, TEMPERATURE AND LEVEL CONTROLS

Since 1900

LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

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Fast Movers or Shelf Warmers?

Count BOTH

(and 1,001 Other Items)

WITH

VARY-TALLY

Multiple-Unit Reset Counter

Vary-Tallies help you separate the sheep from the goats, the big ones from the little ones, the red ones from the green ones—in manufacturing, sales, accounting, researching and what not!

Vary-Tallies will do *any* counting job you want in any combination up to 6 banks high, 12 units wide (with a minimum of 2 units wide). Yes, you can count on 'em or with 'em *to your profit*—note these features of construction:

- **Easily Readable from Any Angle . . . Bold figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation**
- **Easily Portable, yet Ruggedly Built for Long Wear**
- **All Parts Corrosion-Resistant; Working parts of Hardened Steel**
- **Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly**
- **Not Affected by Extreme Heat or Cold**
- **Individual Tag Above Each Counter-Window — Not Strip Tabs**
- **Veeder-Root Quality in Every Part**

How Can the Vary-Tally count for *you*? Write for news sheet and prices.

"The Name that Counts"

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Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada • Dundee, Scotland • Offices and Agents in Principal Cities

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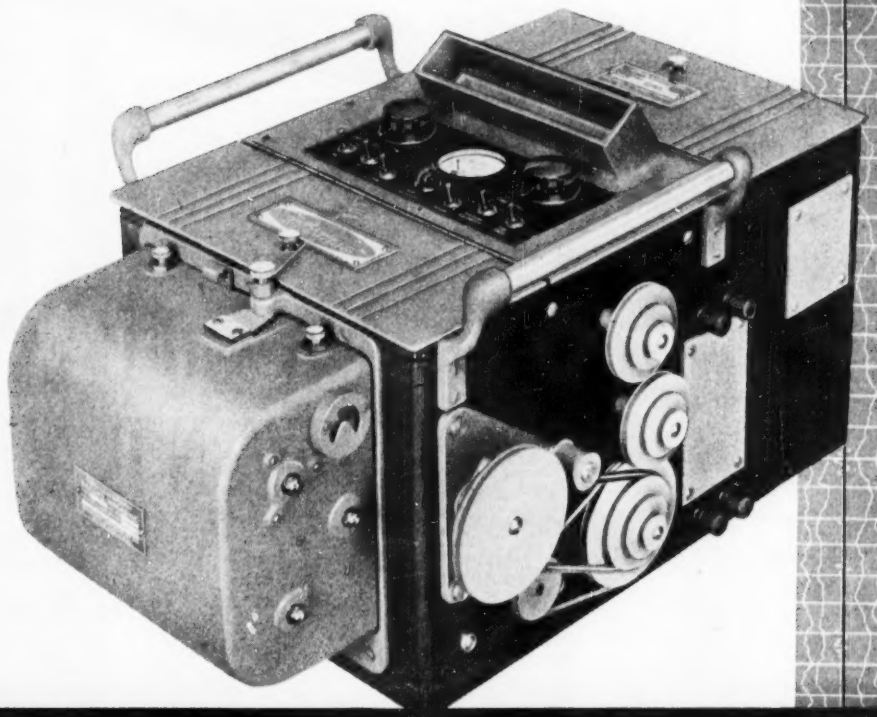
YOU can't afford to be without the HATHAWAY S14-C OSCILLOGRAPH



the world's most complete and versatile OSCILLOGRAPH

for recording electrical quantities, processes, flight functions, dynamic pressure, strain, vibration, acceleration, temperature...

for testing relays

for testing welding equipment

for biological recording

for analysis of high-speed engines and compressors

Galvanometers are available for current, voltage, power, covering a most extensive range of characteristics.

Attachments available for almost any recording need—

automatic transient recording
wave-shape measurements
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long records to 100 inches per second
short records to 1,000 inches per second

PROVE TO YOURSELF THAT THE S14-C IS...

• The Most Versatile • The Easiest to Maintain • The Easiest to Operate • The Finest in Craftsmanship

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400.00 CYCLES

Also available in—

240
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1,000
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ACCURACY: 1 PART IN 50,000

FREQUENCY STANDARDS

IN QUANTITIES

PRECISION WITH RUGGEDNESS

TYPE 2003. Temperature-compensated tuning fork with most of the circuitry sealed inside. Requires a miniature double triode and 6 pigtail components in your circuit.

TYPE 2007. Temperature-compensated tuning fork with ALL circuitry, including sub-miniature double triode, sealed inside.

FEATURES — Plug in
Interchangeable
Shock-vibration resistant
Hermetically sealed
Light weight. (7 ounces)
Small size (1½" x 4½")
Meets JAN-MIL specifications

Manufacturers of a wide variety of timing equipment used in such fields as Aviation, Navigation, Ordnance, Ballistics, High-speed Photography, Viscosity Measurement, Fluid flow, Nuclear Physics, Telemetering, Chemical Reaction, Radiation Counting, Computers, Facismile, Fire control, School and Industrial Research Laboratories. Accurate speed control.

WRITE FOR DESCRIPTIVE LITERATURE, TYPE 2003-7 OR SEND BRIEF OUTLINE OF REQUIREMENTS.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

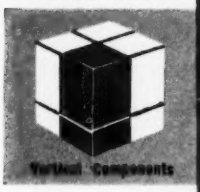
OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

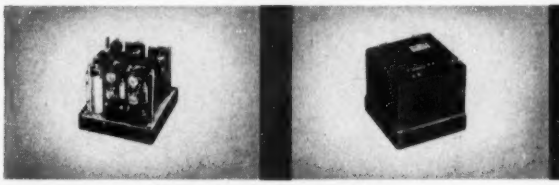
1 IN Complete Telemeter PACKAGE

BY BENDIX - PACIFIC

These compact, rugged FM/FM telemetering packages are available for many types of applications. Numerous models of plug-in subcarrier oscillators and associated components are available as standard equipment to provide for maximum versatility and efficiency.

CUBICAL CONFIGURATION

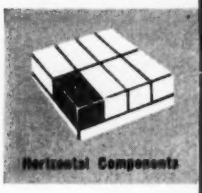


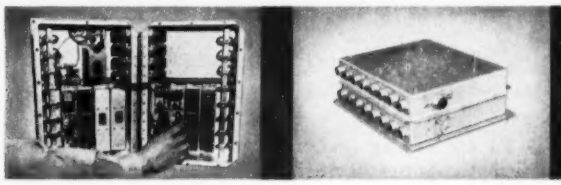


Compact Four Band Telemeter, Models TATP-3 and TATP-4

These packages, each incorporating four plug-in subcarrier oscillators, when used with a power supply and RF transmitter, form a compact, rugged system for telemetering various functions. Each package contains its own voltage regulator and calibration relays. The packages may be combined to form an 8 or 12 band system. Each package measures approximately 4.5" in each dimension and weighs approximately 3 pounds including oscillators. Standard power supplies are available for operating up to 3 packages and a 2 watt RF transmitter. The model TATP-3 operates in any 4 of the RDB bands below 22 kc; the TATP-4 in any 4 of the bands from 22 kc up.

RECTANGULAR CONFIGURATION

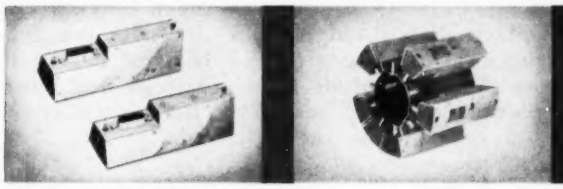




Universal Eight Band Telemeter, Model TATP-2

Operates on any eight RDB bands from 1.7 to 70 kc permitting any combination of 8 resistance, voltage or inductance type measurements to be made by merely plugging in the proper subcarrier oscillators. The unit has provisions for mounting a model TXV-13 crystal controlled transmitter. Connectors are provided for a minimum of eight remotely located pickups. Standard power supplies are available for operation from 6, 12, 28 VDC or 115 VAC 400 cps power sources. Dimensions—14" x 12.4" x 4.75".

CYLINDRICAL CONFIGURATION



Cylindrical Telemeter Configuration, Model TJW-1

These packages are built up of individual 30° wedge shaped components which plug into a cylindrical mounting assembly, Model TJW-1. As many as 10 subcarrier oscillators or other components can be installed into a 6.5" circular opening, 5.5" long. A center opening, approximately 1.5" in diameter, can be utilized for cables and pressure lines. A two-watt crystal controlled RF transmitter is also available for mounting in this configuration.

Write for Complete Information

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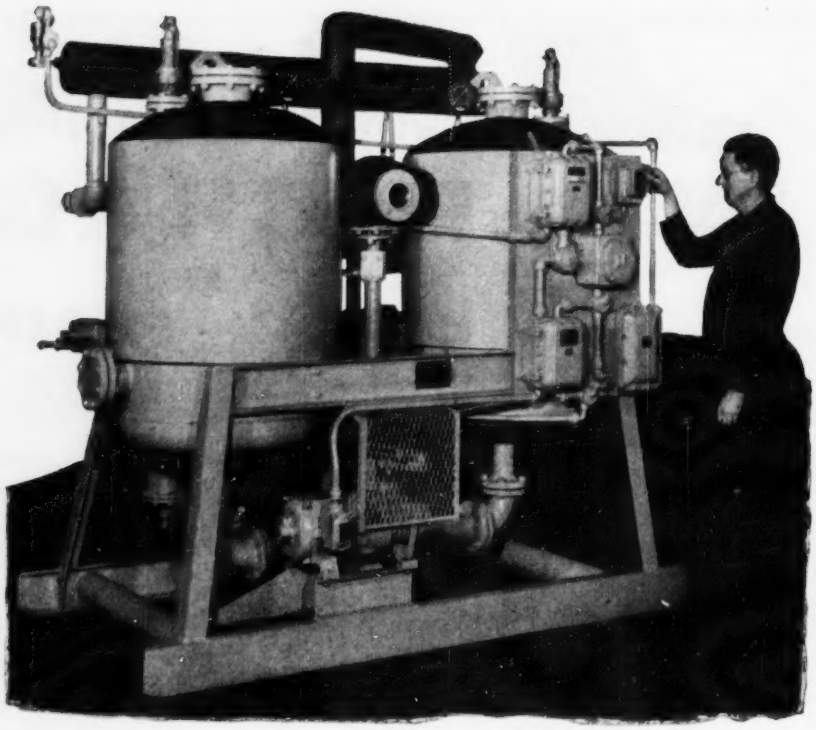

Fully automatic instrument air dryer . . . BY-type Lectrodryer

DRY AIR and how to get it...

Even on the most arid desert, air is wet! Elsewhere, it's wetter. Hence, if you need dry air, you must use machinery to get it.

A Lectrodryer* is an air drying machine. With it you can dry great volumes of air in a continuous flow to prescribed low dewpoints. You can reduce the moisture content of air to a stable constant!

Lectrodryer machines can drop air to dewpoints below −100°F . . . reduce relative humidity below 10%.

There's probably a Lectrodryer already built that meets your drying need. The largest (for a wind tunnel) dries three tons of air per minute to a dewpoint of −70° F. Smaller machines are preserving the interior of Navy ships of the "Mothball Fleet" by maintaining a constant relative humidity below 30%.

Besides air drying, there are Lectrodryers that dry many gases and organic liquids, handling pressures as high as 6000 psi.

If you use air, give some thought to drying it with a Lectrodryer. Write for *Because Moisture Isn't Pink,* a booklet describing Lectrodryers and how industries have used them. Request also, *The Moisture In Our Atmosphere,* a technical booklet on the nature, behavior and measurement of water vapor. Both are free! Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pa.

LABORATORY LECTRODRYER

If your experimentation requires small quantities of dry air or other gases, a Laboratory Lectrodryer will help you greatly. Rated at 100 cubic feet per hour, these machines have in many cases provided the dryness in research that has led to large savings in production.

$155.00
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Pittsburgh

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LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

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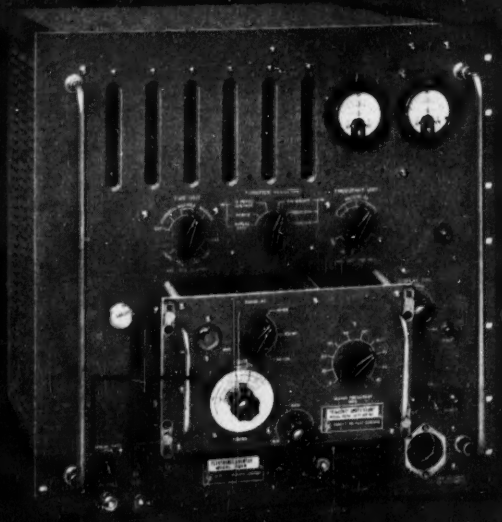

Frequency 10 cps to 220 mc
Interval 1 μsec to 100 days
Period 0 cps to 10 kc

measured instantly, automatically, directly by the revolutionary new...

-hp- 525A
Frequency Converter

-hp- 525B
Frequency Converter

-hp- 526A
Video Amplifier

-hp- 526B
Time Interval Unit

-hp- 524B ELECTRONIC COUNTER

Why buy more instrumentation than you need? The new all-purpose *-hp-* 524B Electronic Counter with Plug-In Units gives you *precisely* the frequency, time interval or period measuring coverage you want now. Later, you can add other inexpensive plug-in units to double or triple the usefulness of the Counter.

Model 524B offers direct, instantaneous, automatic readings requiring no calculation, interpolation or complex instrument set-up. It has high sensitivity, high impedance, and its operation is so simple and dependable it can be used readily by non-technical personnel. Resolution is 0.1 μsec, and accuracy is 1/1,000,000 ± 1 count. Construction throughout is of highest quality components in a compact militarized design.

The new Counter with Plug-In Units gives you more range, more convenience, smaller size and lower cost than any commercial instrument combination ever offered. With this one compact equipment, you readily measure transmitter and crystal oscillator frequencies, time intervals, pulse lengths, repetition rates, frequency drift; make high accuracy ballistics time measurements or high resolution tachometry measurements, or use as a precision frequency standard giving convenience and flexibility not provided in the usual primary standard.

Data subject to change without notice. Prices f.o.b. factory

BASIC COUNTER

The basic *-hp-* 524B Counter unit measures frequency from 10 cps to 10 mc with accuracy of ± 1 count ± stability, reading direct in kc; or measures period from 0 cps to 10 kc with accuracy of ± 0.3% reading direct in seconds, milliseconds or microseconds. Eight-place registration, short term stability 1/1,000,000, display time variable 0.1 to 10 seconds. $1,890.00

COUNTER WITH PLUG-IN UNITS

***-hp-* 525A Frequency Converter** extends Counter's range to 100 mc, maintains accuracy, and increases Counter's video sensitivity to 0.1 volts through basic 10 cps to 10 mc range. $225.00

***-hp-* 525B Frequency Converter** like 525A but extends Counter's range from 100 to 220 mc at 0.25 volts sensitivity. $225.00

***-hp-* 526A Video Amplifier** increases Counter sensitivity between 10 cps and 10 mc to 10 millivolts for low level frequency measurement. $125.00

***-hp-* 526B Time Interval Unit** measures interval 1.0 μsec to 100 days with accuracy of 0.1 μsec ± 0.001%, reading direct in seconds, milliseconds or microseconds. Start, stop triggering in common or separate channels, through positive or negative going waves. $150.00 (Plug-in units supplied in aluminum storage case).

Request complete details today from your -hp- Field Representative, or write direct

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2988C Page Mill Road • Palo Alto, California, U. S. A.

hp INSTRUMENTS | COMPLETE COVERAGE

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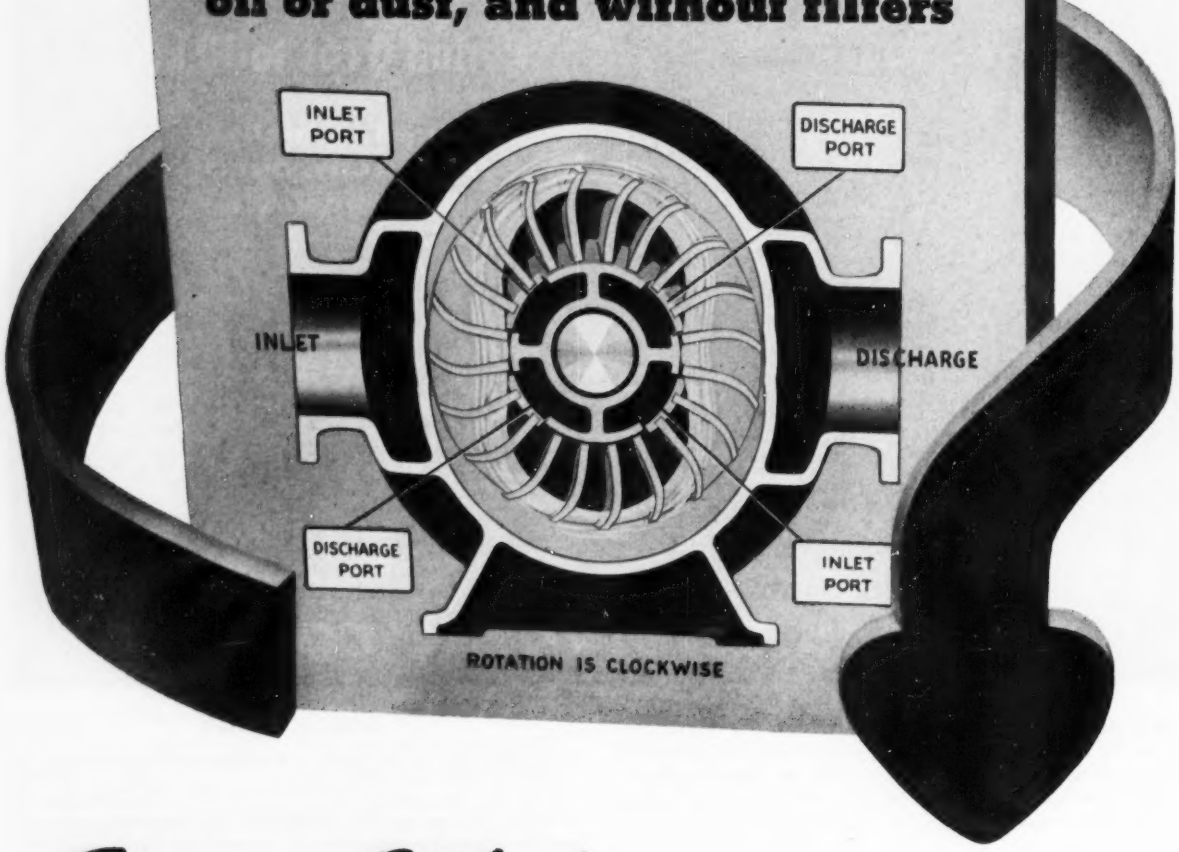
Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
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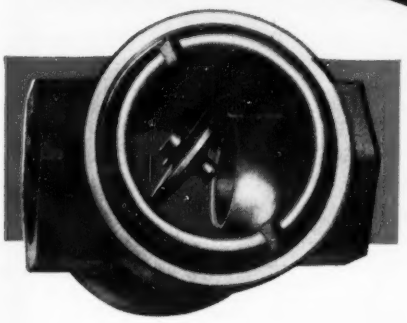
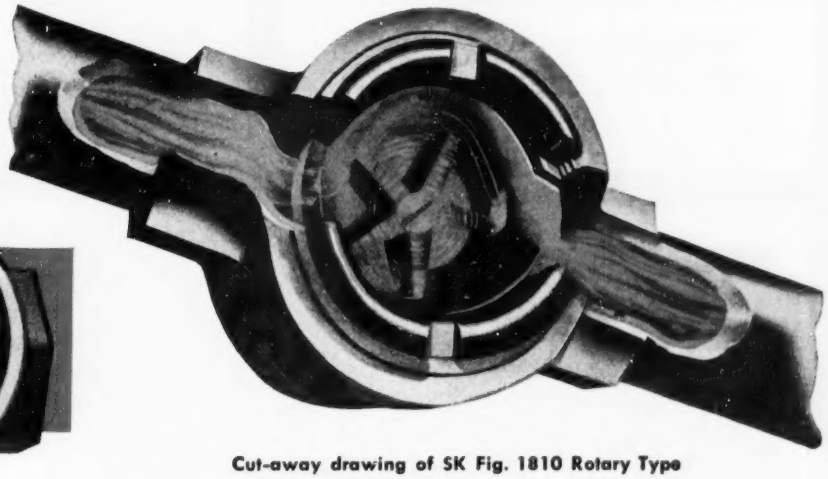
ENGINEERING *News*

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS



Flapper Type Fig. 1801-P Flow Indicator



Cut-away drawing of SK Fig. 1810 Rotary Type Flow Indicator in Operation

SK FLOW INDICATORS PERMIT QUICK CHECK OF FLUID FLOW

Designed to be installed in pipe lines where a visual check of fluid flow conditions and direction is necessary, SK Flow Indicators are finding wide application throughout industry. Where flow failure can damage valuable equipment or cause breakdown of critical machinery, process, petroleum, and plant engineers have found SK Flow Indicators a form of low cost insurance.

SK Flow Indicators are simple mechanical devices which indicate fluid flow and its direction by the position of a flapper or a ball—or by the rotation of a wheel—which may be directly observed through a sight-glass. SK Flow Indicators are suitable for service with any fluid sufficiently transparent to allow the indicating element to be seen. While they provide a positive indication of flow, they are intended only to give a rough indication of whether flow is relatively low or high.*

SK Flow Indicators are designed to give trouble-free service, and operate continuously—even under severe operating conditions—with minimum maintenance.

Only two of the several SK Flow Indicators are illustrated. Bulletin 18-W gives complete construction and performance data on all types. Write for your copy today.

**If you require accurate rate of flow measuring instruments, ask us for Bulletin 18-RA which describes the many types of SK Rotameters.*

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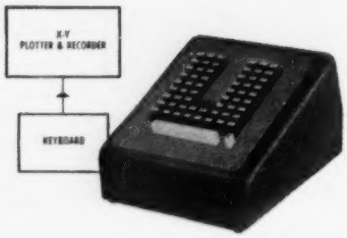
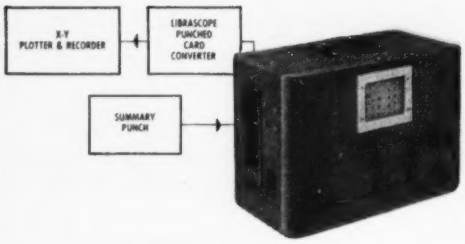


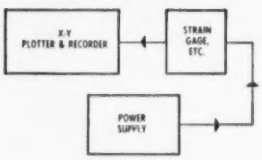
DECIMAL KEYBOARD: Consists of a three-decimal bank for each axis with associated plus-minus keys. Depressing plot bar initiates plot and clears keyboard automatically. Also manual clear button. Size: 8½ x 11 in., Weight: 12 Lbs.



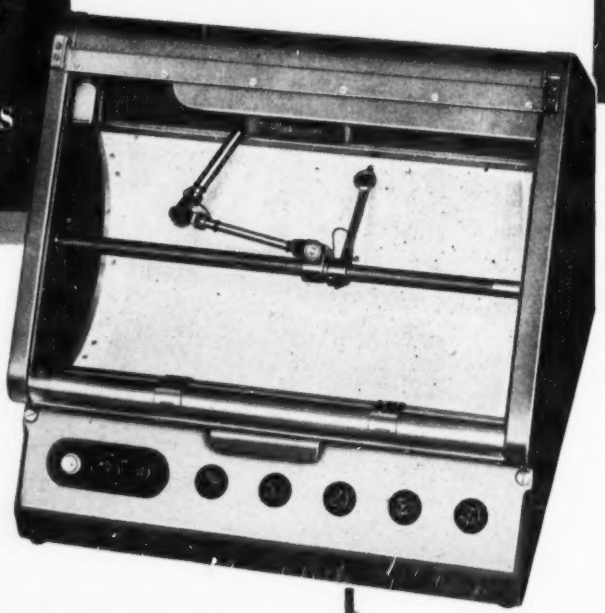
PUNCHED CARD CONVERTER: Converts punched card data to an analog form suitable for input to X-Y Plotter from Gang Summary or Reproducing punches. Display Monitor. Total tube complement 26 tubes.

X-Y plotter and recorder

simplified recording of two independent variables with greater selection of input devices



D.C. INPUTS: 5 millivolt full scale sensitivity on both axes. Infinite input impedance for signals to .5 volts, 2 megohms input impedance above .5 volts.



A compact, desk-size unit that accepts either analog or digital inputs. Standard digital converters: Decimal keyboard, Decimal punched card, and Binary for Computer Outputs. Handles remote mechanical shaft rotations directly without modification. Modifications available to customer specifications. Full chart visibility allows observer to view curve generation at all times. Unique pen travel for fast, dependable performance. Write for full catalog information.

DESCRIPTION:
Desk or Rack Mounted
(RCA or RMA)
Accuracy: .1%
Weight: 70 lbs.
Uses Standard Graph Papers:
11" x 16½", or 8½" x 11"
Power Consumption:
150 watts, 115 volts, 60 cycles

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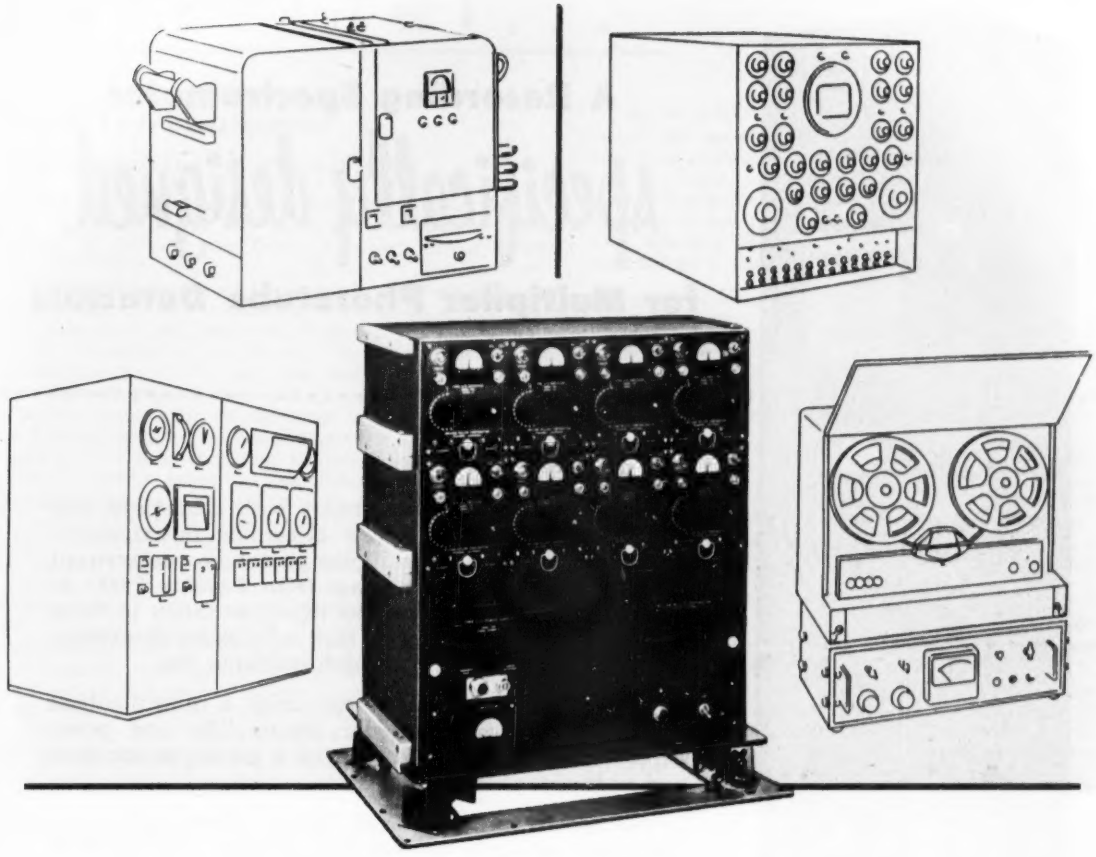

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The most critical element in an entire measurement or control system, the amplifier often determines overall precision. Input from transducers or other signal sources may be accurate; output devices may provide exact indication. But if intermediate circuitry introduces inaccuracies, overall value is greatly reduced. Wm. Miller Instruments offers three basic amplifier types for incorporation in a wide variety of instrumentation systems. Each represents the most advanced, thoroughly tested design in its field; each allows the engineer to retain full advantage of the inherent accuracy of other system elements.

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ANOTHER NEW L&N RESEARCH TOOL

A Recording Spectrometer

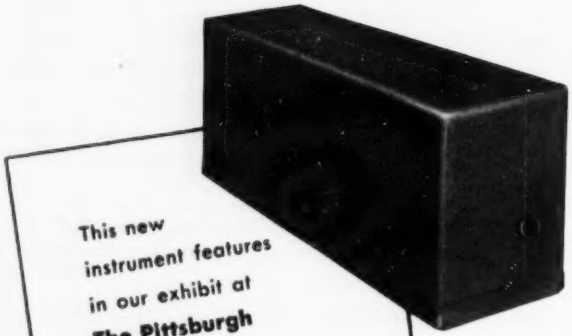
specifically designed

for Multiplier Phototube Detectors

■ Now you can measure directly both ultra-violet and visible spectra with this new Recording Spectrometer. Specifically designed for multiplier phototube measurement of spectral lines over the range from 2,100 to 7,000 A, this unique instrument permits experimentation in flame analysis; isotope-ratio analysis such as hydrogen-deuterium; blood analysis in medical research problems; etc.

The equipment consists of two units: a control cubicle with a Speedomax® Recorder, pre-amplifier and power supply; and a monochromator with a grating motor drive and multiplier phototube.

The spectrum is dispersed by an Ebert-type monochromator with a 30,000 line/inch grating. The spectrum lines are scanned by a multiple-speed grating motor drive. The intensity of these lines is measured by the multiplier phototube, which has a stabilized power supply and dark current adjuster. The measured values of the line intensities, amplified by an 11-range pre-amplifier, are continuously plotted by the Speedomax Recorder.



This new instrument features in our exhibit at **The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy,** March 1-5, 1954.

An outstanding feature is the mobility of the equipment. The control panel is mounted in a rolling cubicle. The monochromator may be mounted on a rolling table, so that the equipment can be brought to the work. Also, the monochromator may be operated remotely from the control panel—an important feature when doing research with radioactive materials.

The excellent performance of this high resolution recording spectrometer is amply demonstrated by a typical experiment in which two lines 0.05 A apart can be resolved in the second order ultraviolet spectrum (3072 A).

For more information about this equipment, write to Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa.

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For more information circle **40** on inquiry card.

Editorial...

First International Automation Exposition

Plans are announced for the First International Automation Exposition, to be held in New York City, November 29-Dec. 2, 1954, at the Coast Artillery Armory (14th Street off Sixth Ave.).

In view of the universal interest in automation, a new kind of engineer and executive who thinks not only of automatic machines and automatic factories, but also of automatic industries, is developing. The First International Automation Exposition will open new vistas to the engineer and executive of this new age of automation.

Modern civilization is changing as new advances are made in automation. As these advances are taking place rapidly, it is important that the developments be placed before American industrial executives and engineers. The Automation Exposition will provide the first opportunity for manufacturers of automation products to exhibit their latest advances to engineers and executives responsible for guiding future production methods.

Automation is defined as the use of automatic control, associated with some type of measurement, for the control of quality and reduction of costs in production. The measurement may be based on the direct measurement of any variable, or it may be the error signal representing deviation from a desired control point.

For complete information, including registration forms, write to the First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa. There is no registration fee.

Analytical Conference

Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy continues to be a conference of national

significance. This year the conference, held March 1-5, was distinguished by the first disclosure of two new instruments and the first exhibition of three others.

Spectracord

The new "Specracord" spectrophotometer recorder was announced for the first time by its manufacturer (Warren Electronics, Bound Brook, N. J.) and exhibited by Fisher Scientific Company (regional distributor). Designed to use the monochromator portion of the Beckman DU manual spectrophotometer, the "Spectracord" accomplishes complete spectral analyses at high resolution in as little as 1½ minutes. A new double-beam principle is used to increase the signal-to-noise ratio.

Recording Spectrometer

Arousing great interest was the first disclosure of the Leeds & Northrup recording spectrometer, designed for phototube measurement of spectral lines from 2100 to 7000 A., which includes both ultraviolet and visible spectra. The instrument permits experimentation in flame analysis, isotope-ratio analysis such as hydrogen-deuterium, blood analysis, etc. The spectrum is dispersed by an Ebert-type monochromator with a 30,000 line/inch grating. Spectrum lines are scanned by a multiple-speed grating-motor drive. Line intensity is measured by multiplier phototube and recorded by a "Speedomax."

Ultrasonic Viscosimeter

Also shown for the first time was the ultrasonic viscosimeter of Ultrasonic Engineering Company, P. O. Box 46, Maywood, Ill. There has been great interest in continuous measurement of viscosity by ultrasonic technique since the introduction of the "Ultra-Viscoson," now offered by Cincinnati Division, Bendix Aviation Corp., 203 W. 3 St., Cincinnati, Ohio. The ultrasonic viscosimeter of Ultrasonic Engineering differs from the Bendix "Ultra-Viscoson" in that the probe of the former is driven continuously and its amplitude of motion is measured; the probe of the latter is pulsed, with the time between pulses being used as a basis of measurement.

X-ray Quantometer

Also exhibited for the first time was the recently announced x-ray Industrial "Quantometer" of Applied Research Laboratories, Glendale 8, Calif. Designed for production control, this instrument can be used for high-speed chemical analyses wherever x-ray fluorescence techniques are applicable. This includes complex alloys, ores, and concentrates where elements range in atomic number from 21 to 92. A variety of analyzers are available, dispersive and nondispersive. Spectral range is 0.6 to 3.1 A.

Decade Scaler

The recently revealed E1T-tube decade scaler of North American Philips was displayed for the first time and aroused much interest. The new input rate is better than 100 kc. The scaler is designed for six-digit counting and scaling for applications requiring high resolving power.

Computer, Analyzer

Recently announced, the descriptive presentation of the new CEC "Model 203" office and industrial digital-type computer aroused interest at the exhibit.

Although not a "first-showing," the "Model 34-104" digital mass-spectrometer data analyzer "Spectro-SADIC" of Consolidated Engineering was of particular interest to the chemical process engineers at the exhibit because it was shown tied into the control loop, thus effecting the much-discussed quality-controlled closed-loop automatic process control.

In This Issue

Of particular significance in this issue are the following:

(1) New design requirements for process control equipment are presented by C. R. Otto of E. I. DuPont de Nemours & Co. in the article beginning on page 608. These requirements are being necessitated by the economies which can be realized through use of higher throughputs with less material in storage.

(2) The final installment of the series "Nuclear Reactors for Industry & Research" begins on page 612. This important series will be available shortly as a book—the first complete book on selection, operation, and use of privately owned reactors.

(3) The tenth installment of the series "Control of Chemical Processes," beginning on page 622, presents a résumé of commercially-available electric and electronic controllers—those that generate proportional, reset, and rate control actions by electric and electronic methods.

The Month's NEW INSTRUMENTS

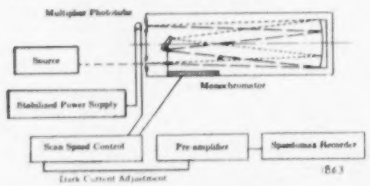
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 657

PROCESS CONTROL

Recording Spectrometer

New Recording Spectrometer specifically designed for photomultiplier detection combines high resolution (two lines 0.05 A.u. apart) over a



wide spectral range (2100-7000 A.u.) with high-speed direct recording of spectral line intensities (any spectral line drawn within 3 seconds). Using a single-pass single-mirror autocollimating system, Ebert-type monochromator has extremely sharp image since all object-to-image distances are equal. Grating (30,000 l./in.) is smoothly rotated automatically for continuous scanning (8 speeds), or may be precisely positioned manually. Equipment comprises two assemblies: (1) grating monochromator assembly for table-top mounting; (2) wheeled recording and electronic cubicle 22 in. wide, 18 in. deep and 80 in. high. Recorder is curve-drawing "Model S Speedomax" self-balancing d-c. potentiometer, 2-sec. balancing time, chart speeds 2 ips. and 4 iph., solenoid-operated pen-lifter, etc.—*Leeds & Northrup Co., 4955 Stenton Ave., Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

Spectrophotometer

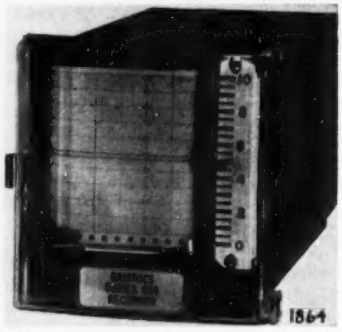
New "Kruger Spectrophotometer," designed for measuring light absorbance or transmittance of solutions, is a new type of spectrophotometer with a wedge interference filter for monochromator. This new design is

said to result in "sturdy, simple construction combined with exceptionally good performance at a low price." Band-width is narrower than obtainable in grating instruments: much narrower than obtainable from absorption-type light filters. Wavelength can be set to any value between 420 and 680 millimicrons.—*Harold Kruger Instruments, P.O. Box 164, San Gabriel, Calif.*

For more information circle **202** on inquiry card.

Pneumatic Instrumentation

New "Metagraphic System" is a three-part air-operated system with each basic function packaged separately: a transmitter, a receiver (recorder or indicator), and a controller. Each unit can be installed on process at optimal point. "Metagraphic" instruments measure, indicate, record, and control pressure, vacuum, temperature, level, flow-rate, etc. Air pressure signal (3-15 or 3-18 psi.) interconnects three units no matter what variable is being transmitted,



making components universally interchangeable. New receivers and controllers are designed for full plug-in service. Strip-chart recorders, and indicators, are interchangeable without loss of signal or control. Among features: continuous valve position indication, "bumpless" manual-automatic transfer, and high-output-capacity setpoint regulator. Controllers are offered in five modes of control: on-off, proportional, proportional plus reset, proportional plus derivative, and three-mode.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **203** on inquiry card.

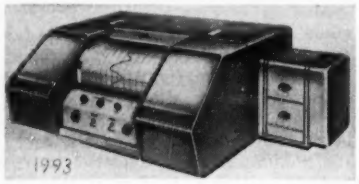
Conductance-cell Assembly

New "Conductivity Flow Cell Assembly" features ease of removal of cell for cleaning or inspection; is less than 10 in. long; with cell itself so small that there is practically no holdup to level out differences in conductivity. Assembly can be furnished with cells having different constants. A bimetallic dial-indicating thermometer is a standard component. Aside from glass cell, principal "wet" components are stainless steel. —*Hagan Corp., P.O. Box 1346, Pittsburgh 30, Pa.*

For more information circle **204** on inquiry card.

RecordingSpectrophotometer

New "Spectracord" spectrophotometer is said to accomplish complete spectral analyses at high resolution in as little as 1½ min., by use of advanced servo techniques with a minimum of electronic components packaged in replaceable plug in units. It operates automatically on a double



beam principle employing "Warren Photometer" said to "greatly improve signal-to-noise ratio over conventional photometers." Other features: spectral bandwidths as low as 5 A.u. in ultraviolet; large preprinted charts (11 x 17 in.) which fold to standard letter size; basic design allowing recording both absorption and emission spectra; recording absorbance vs. time; repetitive scanning at selected wave-length ranges. Standard parameters are wave-length ranges of 2180-3750 and 3500-7500 A.u. *vs.* transmittance; others available. "Spectracord" is compatible with existing equipment: designed to use monochromator portion of DU Manual Spectrophotometer and all sample cells normally employed in DU instruments.—*Warren Electronics, Inc., Bound Brook, N. J.*

For more information circle **205** on inquiry card.

Multi-range pH Meter

New panel-mounted automatic pH meter is said to be "the first industrial pH meter to accommodate virtually any combination of recorder and

meter ranges." Circuit allows recorder pH scale to be shifted up or down, expanded or compressed; entire pH range or as few as 3 pH units can be recorded full-scale on recorder chart. Possible accuracies within 0.02 pH in output to recorder.—*Beckman Instruments, Inc., South Pasadena, Calif.*

For more information circle **206** on inquiry card.

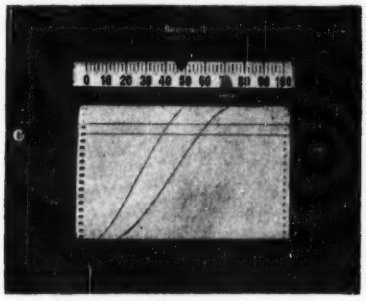
Automatic Controllers

New models of "Pyr-O-Vane" and "Protect-O-Vane" control pyrometers have had their measuring circuits modified to permit calibration of instruments for a number of functions other than temperature: measuring and controlling speed of rotation, power consumption, pH, pressure, etc. Accurate to within 1 percent, these millivoltmeter-type instruments are also suited for uses in research or development activities where potentiometer type instruments are not required.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **207** on inquiry card.

Two-function Plotter

New "Electronik Duplex Function Plotter" measures two variable conditions and simultaneously plots their relationship to a third. It incorporates three complete measuring and balanc-

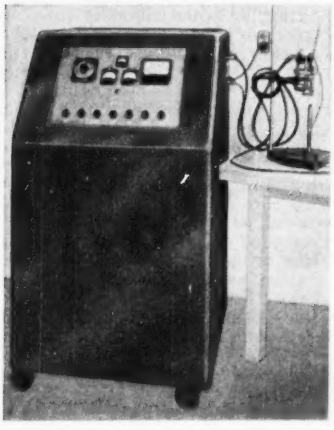


ing circuits: two actuate recorder pens horizontally across specially-calibrated chart to record two conditions; third moves chart up or down as it measures third variable. All three circuits can be actuated by any d-c. source and can be calibrated for the same or entirely different ranges and actuations; e.g., pens may record temperature and speed while chart travel represents pressure.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **208** on inquiry card.

Automatic Controller for Reductions and Oxidations

New "Redox-O-Trol" provides automatic control of electrochemical reactions by controlling electrode poten-



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A NEW LOCATION
The entire Struthers-Dunn factory and headquarter offices have been moved to a new location, approximately 15 miles Southeast of the Philadelphia-Camden Area.
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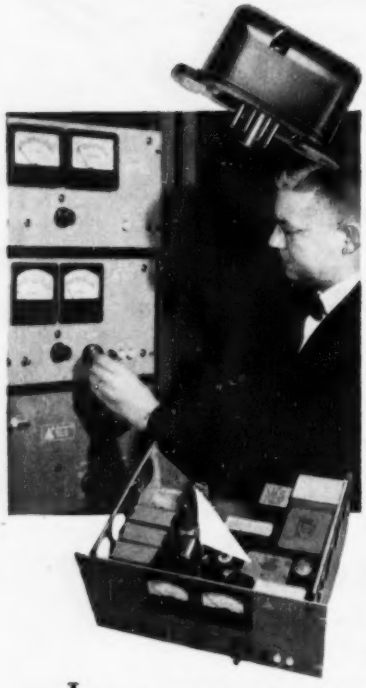
5,348 RELAY TYPES

For more information circle **41** on inquiry card.

BARBER COLMAN

ultra-sensitive relays

provide accurate repeatability in alarm circuit of new nuclear reactor control instruments



In developing the alarm circuit for its Log N Amplifier, which measures current from an ionization chamber and indicates reactor power over a range of six decades, Radiation Counter Laboratories, Inc. of Skokie, Illinois, could not obtain accurate repeatability in the limited chassis space with an electronic circuit. By using the "Micropositioner" they found the answer.

Ideal for hundreds of industrial applications, Barber-Colman d-c polarized relays are ultra-sensitive, stable, and vibration-resistant. High-speed response—can be operated in excess of 100 cps.

Available in a wide range of coils, enclosures and mounting details. Extensively used in balance-detecting bridge circuits and as plate current relays in electronic applications with an important saving in space.

Write today for Bulletin F3961-2

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For more information circle **42** on inquiry card.

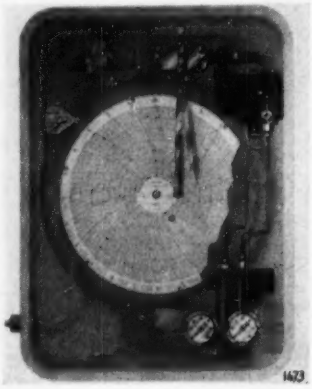
NEW INSTRUMENTS

tials within 100 mv. (usually less than 50 mv.). Outputs delivered by it range from 0.1 to 7 amps. at voltages from 1 to 27. Versatility: it may be used to control energy output to an electrolytic cell or other system as a function of any parameter of system (e.g. electrode potential) capable of being expressed as a d-c. potential between 0.4 and 9 volts.—*American Instrument Co., Inc., Silver Spring, Maryland.*

For more information circle **209** on inquiry card.

Pneumatic Transmitter

New pneumatic signal transmitter makes "Ring Balance Meter" readily adaptable to remote metering and control applications, among them control installations requiring reset, remote adjustable set point and rate action. Available maximum signal pressure ranges are 15, 30 and 60



psi.; minimum signal pressure substantially zero or suppressed to 3 or 5 psi. Built-in proportional-band adjustment from 10 to 300 percent at any time without affecting zero setting. Applicable for transmission or control service when actuated by other measuring components such as temperature, pressure, position or programming.—*Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.*

For more information circle **210** on inquiry card.

pH Meter

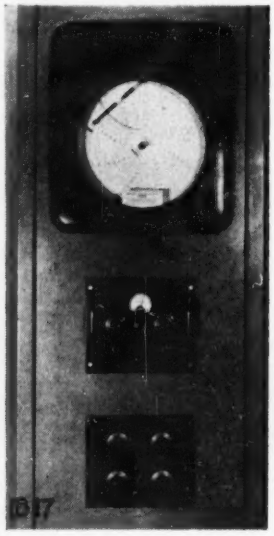
New "Model 115" line-operated pH meter, for laboratory work as well as process control, is said to bridge gap between early complicated electronic instruments and visual color-comparison tests of limited accuracy; is said

to cost little more than better-grade color-comparison set. Four-inch scale with 140 divisions permits reproducible readings to 0.05 pH, continuous through neutral point without range switching. For titrations, millivolt scale +400 to −400, also +800 to −800 for use with voltage divider. Needle can be adjusted for zero center or for zero at either end of scale.—*Photovolt Corp., 95 Madison Ave., New York 16, N. Y.*

For more information circle **211** on inquiry card.

Duplex Infrared Analyzer

New "Dual Infrared Analyzer," first commercially-available instrument of its kind, continuously analyzes two



components in a complex gas stream. Cost and complexity are only slightly greater than for maker's single-component instruments.—*Liston-Becker Instrument Co., Inc., 653-A Hope St., Stamford, Conn.*

For more information circle **212** on inquiry card.

Recorder Pen Lifter

New automatic pen-lifting device, for single-record strip chart recorders, comprises a rod and lever arrangement, operated by a solenoid, which raises pen clear of chart depending upon requirements of application: during "off" periods to prevent ink blots, or during periods of chart changing, or when chart is torn off recorder, or when measured variable falls below any selected value. Lifter can be wired so that pen is lifted when chart motor is turned off. For test cell applications terminals can be provided at rear of instrument for external wiring in order that user may remotely operate chart drive switch and pen-lifter solenoid. New device can be used either with conventional or ball-point pens and can be installed on instruments with either one or both left- and right-hand operation pens. It is also useful on maker's "Function Plotter" (where a series of records may be made on one chart) to prevent pen from marking chart during retrace.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **213** on inquiry card.

TEMPERATURE

Temperature Controller

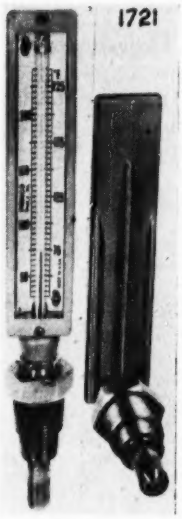
New "Series 97" two-z ne electronic temperature controller is said to feature high sensitivity (0.25 F.), long-term stability, and low cost. It uses a resistance primary element in a

bridge circuit in conjunction with a high-gain phase-sensitive amplifier relay unit. Red and green lights indicate temperatures above or below set point. Single-pole two-way control contact handles 220 volts at 5 amps. Standard ranges 0/100/300/500 F. and C. but any range between −200 and 500 C. can be supplied.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 North 4th St., Philadelphia, Pa.*

For more information circle **214** on inquiry card.

Industrial Thermometers

New 5-in. scale mercury-in-glass industrial thermometers, with separable sockets, are designed for restricted-space applications. Five case angles: straight, 90-deg. rear angle, 90-deg. right and left side angles, and 135-deg. oblique angle. New separable sockets are threaded for both ½-in. and ¾-in. N.P.T. (see illustration for detail of the dual-diameter threaded shoulder). Two stem lengths are available. Conducting medium between stem wall and thermometer bulb is powdered aluminum.—*Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.*



For more information circle **215** on inquiry card.

Temperature-alarm Cable

New kind of temperature indicator housed in a flexible steel wire rope, for use in detecting deterioration in stored grains, "consists of a plastic-coated copper circuit, with constantan thermocouples every five feet, inside the wire rope." At a central reading point,

CHATILLON

ISO-ELASTIC* SPIRAL SPRINGS

in the Heart of SAFE FLIGHT Lift-Transducers

SAFE FLIGHT
INSTRUMENT CORPORATION
February 16, 1954
John Chatillon & Son
85 Cliff Street
New York, New York
Attention: Mr. H. Gerard Pangmann
General Manager, Spring Division
Gentlemen:
We wish to acknowledge your cooperation in expeditiously constructing a precision Iso-Elastic spring to meet the exacting specifications of our Lift Transducer.
Our Quality Control Department has advised that tests of production units show that the quality of Chatillon springs is one of the factors which enables our Lift Transducers to meet our high accuracy standards.
The tolerance of measurement of our Lift Transducers is maintained over temperature extremes of -65°F to 325°F after exposure to applicable environmental, vibration and shock tests as set forth in USAF Specification 41065-B.
The existing specification for our equipment, which is presently installed on many high performance military and transport aircraft, requires only the finest and most dependable springs. The high quality of your precision-manufactured springs has enabled our engineers to specify their use with confidence in our Lift Transducer which is the source of intelligence for the entire Safe Flight Landing Speed Indicator System.
We appreciate the efforts of your company in meeting our critical delivery requirements and in maintaining the uniformly high standards of your products.
Very truly yours,
Leonard M. Greene
Leonard M. Greene
President
Specialists in Aircraft Safety Equipment
TRANSDUCER

*U.S.A. Pat. No. 2174171

The Spring Division of John Chatillon & Sons through its capable engineering staff has successfully designed and produced Iso-Elastic springs to meet the exacting specification requirements of the Safe Flight Lift-Transducers. Iso-Elastic alloy is a special temperature-compensated material developed with the assistance of Professor A. V. De Forest of M.I.T. and Professor F. Sayre of Union College and produced solely by John Chatillon & Sons. During recent years, the importance of Chatillon Iso-Elastic Springs has been recognized in the aircraft, instrument and electronics fields since their precision spring requirements include constancy of spring characteristics within the usual Aircraft temperature ranges.

Let us show you how we can improve your instruments! Contact Chatillon Spring Division for assistance in redesigning your present springs. Engineering bulletins on Chatillon "Iso-Elastic" alloy and springs are available on request.

JOHN CHATILLON & SONS

85 CLIFF STREET, NEW YORK, N. Y.

Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **43** on inquiry card.

FOR HIGH-SPEED SEARCHING

GIANNINI

TELEMETERING COMMUTATORS

Precision-engineered to sample at rates as high as 1800 per second, Giannini Commutators are ideal for use in such applications as radio and wired telemetering—automatic programming—sequence switching—synchronization of mechanical motion with electrical operation. Rhodium-plated printed circuits of almost endless variety meet individual requirements—and switching may be either "make-before-break" or "break-before-make".

Available as either single or double pole model—with up to 60 channels per pole. Dustproof construction and an unusual contact cleaning device keep the switch noise-free during an exceptionally long life.

Incorporates all the features of the 85561—and is motor driven at a constant speed, governor-controlled; at variable speed controlled linearly with applied voltage; or with other special drives.

Giannini

Further information! Special problem? Please write:

G. M. GIANNINI & CO., INC.

ElectroMechanical Division

East Orange • New Jersey

For more information circle **44** on inquiry card.

NEW INSTRUMENTS

rotary switches make individual connections to each of thermocouples placed throughout stored grain, and temperature at each point is indicated. (Cable is made under license from PTC Cable Co., St. Paul, Minn. Rotary switches by JBT Instrument Co., New Haven, Conn. Indicating instruments by Foxboro Co., Foxboro, Mass.) "PTC Cable" comes in any length up to 190 feet; can be installed vertically or horizontally in any shape or type of storage bin.—*Jones & Laughlin Steel Corp., Gateway Center, Pittsburgh* 30, *Pa.*

For more information circle **216** on inquiry card.

Portable Potentiometer

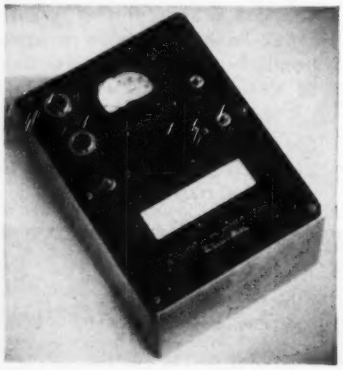
New "Model E-3046" portable potentiometer has a 15-in. circular scale which may have 300 or more easily-

read divisions. Scales may be calibrated in millivolts or in degrees C. or F. for any type of thermocouple. Single or double ranges available. All temperature-range instruments have automatic reference-junction compensation. Feature: magnetic locking of galvanometer system when standardizing key is in center position. Galvanometer sensitivity is such that readings can be made to a small fraction of a scale division. Two sets of binding-posts and selector switch so two sources of emf. may be read in rapid alternation. Accuracy (of calibration) 0.2 percent of full-scale.—*Gray Instrument Co.*, 64 *W. Johnson St., Philadelphia* 44, *Pa.*

For more information circle **217** on inquiry card.

Thermistor Thermometers

New "Climate-Survey Temperature Indicators" are available in three models: "Model 196," six overlapping

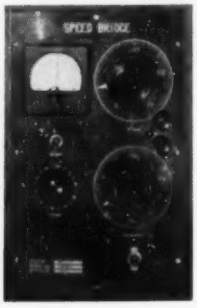


ranges spanning from –70 to 60 F.; "Model 197," six overlapping ranges spanning from 10 to 140 F.; and "Model 198" with one range from 60 to 90 F. Primary elements consist of thermistor pairs in parallel, are hand-calibrated; a standardized replacement service is available. Each instrument has two input receptacles and a selector switch so that reference-temperature or wet- and dry-bulb readings can be made.—*Beckman & Whitley, Inc.*, 1096 *E. San Carlos Ave., San Carlos, Calif.*

For more information circle **218** on inquiry card.

Multi-purpose Bridge

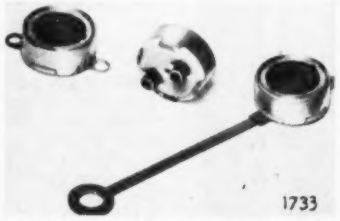
New "Type BT Speed Bridge" is chiefly intended to be used with primary measuring elements with a substantially exponential characteristic curve; may be operated in conjunction with any high-resistance element. Its scale resembles that of a Beckmann thermometer: with main slide-wire at zero, bridge is balanced at initial temperature by two auxiliary slide-wires (coarse and fine). Temperature change is then read on scale of main slide-wire, which has 1,000 divisions. With thermistors or other similar primary elements, a sensitivity of 0.001 deg. per division can be easily obtained; 0.00001 deg. is possible. Instrument operates from any 115 v. 60-cycle line.—*Weiller Instruments Corp.*, 95 *Broad St., New York* 4, *N. Y.*



For more information circle **219** on inquiry card.

Snap-action Thermostat

New "Stemco Type A" is a quick make and break thermostat for electronic, appliance and industrial apparatus. Rapid response and close control are said to be due to: (1)



brass housing of bimetal disk mounted against controlled surface; (2) current carried through a copper contact spring insulated from thermal element, making bimetal electrically independent and eliminating "jitters." Units are precalibrated at factory. Maximum operating temperature 400 F.—*Stevens Mfg. Co., Mansfield, Ohio.*

For more information circle **220** on inquiry card.

Thermoscopic Crayons

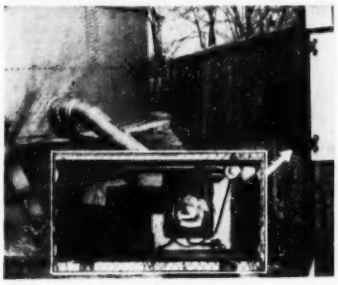
New "Tempilstiks" for 425 and 475 F. are added to maker's series of surface-temperature indicators.—*Tempil Corp.*, 11 *West 25th St., New York* 10, *N. Y.*

For more information circle **221** on inquiry card.

FLOW, LEVEL, etc.

Audible-signal Remote Measuring System

New "Metaphone" makes it possible for an employee of a gas or water utility company to telephone a remote

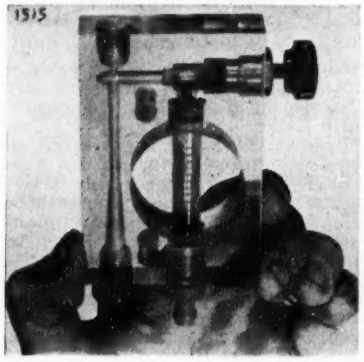


unattended gas holder, water reservoir, etc., and get "readings" at any time of day or night, from any telephone, even from a radio-telephone-equipped truck. It can be installed at any point in a plant or system. It answers phone and gives its reading by a buzzer signal whose duration is proportional to height of water in tank, to pressure of gas in holder, etc. Example: if a 60-ft. tank is full to 40 ft., buzzer sounds for 40 seconds, is quiet for 20 seconds, then repeats 40-second signal. Cost of installing and operating is relatively low and new system may often be more useful than a conventional telemetering system to a supervisor who moves about a plant or city.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **222** on inquiry card.

Chemical Feeder

New "Feedrator," for simultaneously metering, controlling, mixing and dispensing small proportions of



liquid chemicals into liquid streams, includes a built-in ejector which obviates need for a proportioning pump. Four standard models, reagent capacities from 0.03-0.3 to 2-20 gph.—*Fischer & Porter Co.*, 19 *Jacksonville Rd., Hatboro, Penna.*

For more information circle **223** on inquiry card.

Condensate Pump

New "Bantam" miniature condensate pump, said to be "the tiniest, neatest, completely automatic pump of its kind ever built" (5x8x5 in.),

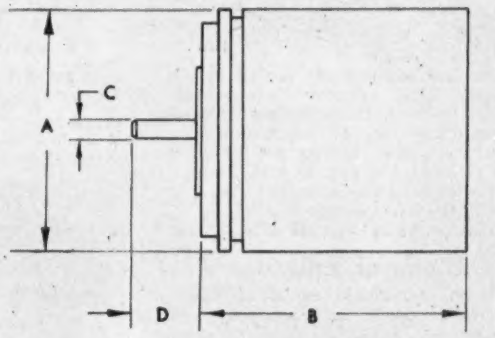
Kearfott developed Servo Motors
... *in production*

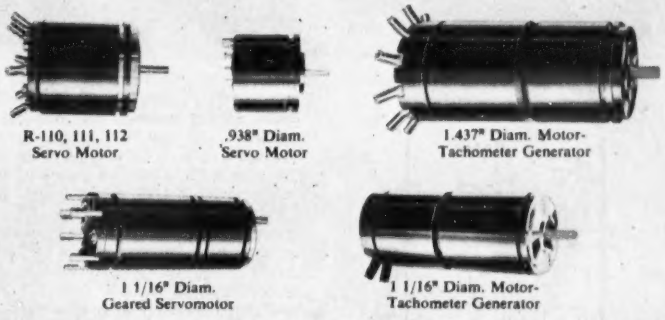
A Navy BuOrd Size 9 to Size 18

B From 25/32" to 1 57/64" long

C Plain Shafts .1200" and .1721" Diam.
Pinion Shafts—13 Teeth 120 Pitch .1247" O.D.
15 Teeth 96 Pitch .1771" O.D.

D Plain Shafts from 5/16" to 1/2" long
Pinion Shafts from 5/32" to 7/16" long





R-110, 111, 112 Servo Motor

.938" Diam. Servo Motor

1.437" Diam. Motor-Tachometer Generator

1 1/16" Diam. Geared Servomotor

1 1/16" Diam. Motor-Tachometer Generator

Shown Approx. 1/2 size

Characterized by very low rotor inertia, low time constants and high stall torque, Kearfott Servo Motors are available for your most exacting requirements. Unitized housing and stator construction makes possible optimum performance under extreme environmental conditions.

For either 26 or 115 volt, 60 or 400 cycle excitation, stall torque values range from .30 to 3.5 oz.-in. Geared Servo Motors in the same diameters can be provided with reduction ratios ranging from 10:1 to 300:1. Various Motor-Generator combinations provide ½ to 3.1 volts per 1000 R.P.M. with linearity, over a speed range of 0-5400 R.P.M., of 1% for damping or .1% for computing purposes.

Send for Bulletin describing Servo Motors of interest to you.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Miniaturized Vacuum Tube and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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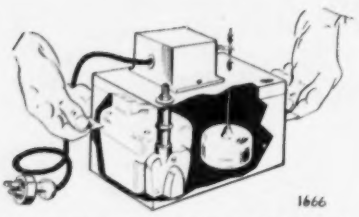
KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Midwest Office: 188 W. Randolph St., Chicago 1, Ill., West Coast Office: 253 N. Vinedo Ave., Pasadena, Calif.

A General Precision Equipment Corporation Subsidiary

For more information circle **45** on inquiry card.

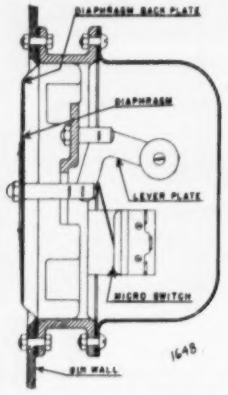


has motor hermetically sealed in oil, Underwriters approved glass-insulated terminals, Neoprene seal housed in stainless steel, all external screws also of stainless. Discharge: 180 gph. at 1 ft. head, 115 gph. at 4 ft., 28 gph. at 8 ft.—*Samuel S. Gelber Co.*, 162 *N. Clinton St., Chicago 6, Ill.*

For more information circle **224** on inquiry card.

Bin-level Indicator

New lower-priced model of "Bantam Bin-Dicator" is a refinement of original small-size model; offers wider versatility. Housing is so designed that it may be mounted outside thin-

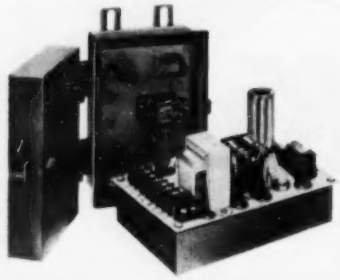


walled bins, inside thick-walled or multiple compartment bins, or suspended within bins. Its 4-in. flexible diaphragm is ample for requirements of small containers.—*The Bin-Dicator Co.*, 205-13946 *Kercheval, Detroit* 15, *Mich.*

For more information circle **225** on inquiry card.

High and Low Flow Alarm

New "Flo-Gard" fail-safe alarm device for rotameters, manometers, and similar process instruments, is said to offer an unequaled range of sensitivity for both high and low flow sig-



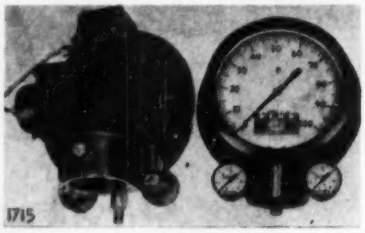
nalling and to be the only alarm system available which can operate accurately in conjunction with spherical floats as small as 3/32 in., permitting use on smallest rotameter capacity ranges. Sensitivity: one millimeter of float position change. In event of power failure, or failure of any electronic component, load relay will drop out and operate alarm contacts.—*Brooks Rotameter Co., Lansdale, Penna.*

For more information circle **226** on inquiry card.

PRESSURE and VACUUM

Pressure Gages with Pneumatic Transmitter

New "Pressure Gage - Pneumatic Transmitter," suitable for unprotected outdoor installation, may be mounted on 2-in. pipe pedestal, wall or

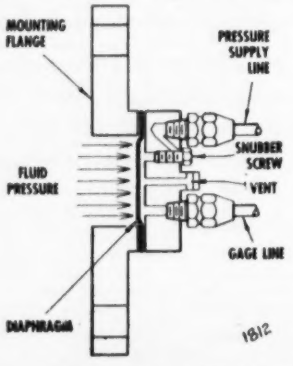


panel. Output 3-15 psi. (5-25 psi. if specified) regardless of range of pressure being measured. Ranges from vacuum to 10,000 psig. available. Gages are AA Grade, in 6-in. or 8½-in. size with Bourdon tubes of various materials. Each instrument is calibrated with comparison of actual pressure applied to gage versus transmitted air. Distances up to 1000 feet are practical for remote indication or recording; up to 400 feet for control. —*Penn Industrial Instrument Corp.*, 4110 *Haverford Ave., Philadelphia* 4, *Pa.*

For more information circle **227** on inquiry card.

Pressure Transmitter

New "Model 6100F Pressure Transmitter," for use with pneumatic instruments, provides a positive seal be-

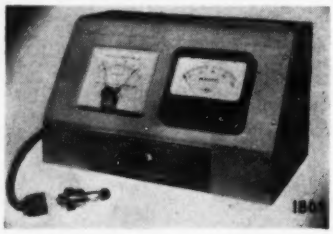


tween gaging system and fluid measured; can be used with practically any fluid and with various types of receivers including recorders or controllers. Two or more receivers can be used with one transmitter. It is essentially a 1-to-1 transmitter with linear response from 0.5 in. water upward. It reads to 20 psi. in vented tanks and to 45 psi. in pressurized tanks; withstands overpressures of 250 psi.—*King Engineering Corp., Box* 540, *Ann Arbor, Mich.*

For more information circle **228** on inquiry card.

Vacuum Indicator-controller

New vacuum indicator-controller automatically maintains a vacuum system in any pre-set range between 1

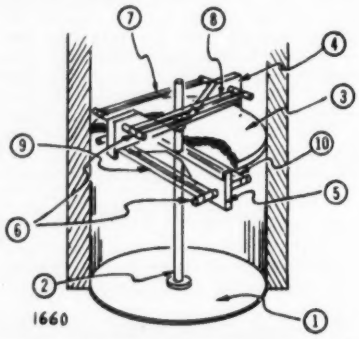


and 1000 microns of mercury on logarithmic setting scale; provides upper and lower limit control; utilizes gage tubes with noble-metal thermocouples and nickel-plated housing which afford freedom from outgassing and system contamination. Gage tubes not affected by release to atmospheric pressure or changes in ambient temperature.—*Hastings Instrument Co., Inc., Hampton* 11, *Virginia.*

For more information circle **229** on inquiry card.

Pressure Pickups

New high-performance pressure pickups, based on novel "Dynawheel" design, feature a diaphragm diameters, ¼, ½, 9/16, ¾, and 1 in., handle



pressure ranges as low as 0 to 1 psi. and as high as 0 to 3000 psi., gage or absolute pressure. Accuracy better than 1 percent of full scale. Temperature range –65 F. to 350 F. New "Dynawheel" design employs an unbonded strain gage, formed into a resistance bridge having four active arms. Natural frequency is above 2000 cps. even for full-scale pressures of only 1 psi. and is above 15 kc. for pressures over 1000 psi. ★"Model C-10 Pressure Pickup Calibrator" gives quick readings of peak and average pressures and provides excitation voltage to "Dynawheel" bridge circuit.—*Dynamic Instrument Co., Inc.*, 28 *Carleton St., Cambridge* 42, *Mass.*

For more information circle **230** on inquiry card.

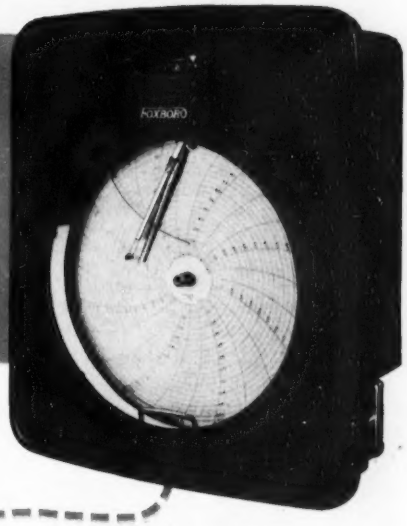
TIME, SPEED & COUNT

Servicing Timers

New "Serviceman Timer" gives the serviceman positive proof of running time and elapsed time of any unit under test. Two standard models: (1) 115-v. 60-cycle model for use on domestic refrigeration and small commercial units using compressors of ¾

An unbeatable team for temperature measurement

DYNALOG RECORDERS and DYNATHERM BULBS



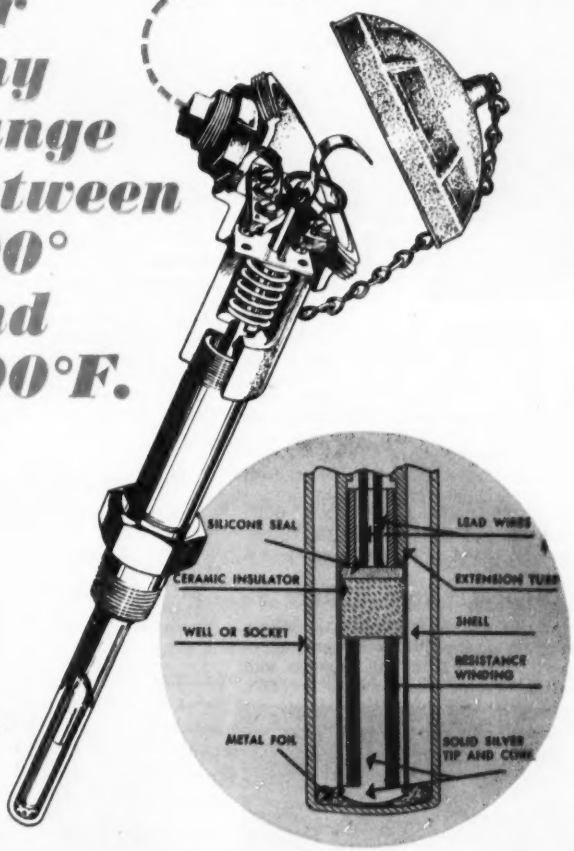
You can't beat this Foxboro Dynalog-Dynatherm combination for insuring better temperature measurement on any job between–100° and+600°F. It gives you every advantage of speed, accuracy, long leads, simple installation, economy, and freedom from maintenance. This is why:

The Dynalog Electronic Recorder has an exclusive variable-capacitor measuring system which eliminates slidewires, gears, cables, high speed balancing motors . . . no dead space, no batteries to standardize, no motors to service. Standard full-scale pen speed only 3 seconds. Sustained accuracy ¼ of 1% guaranteed. Available for spans as narrow as 5°F. with full-accuracy calibration.

The Dynatherm Resistance Bulb has unique features including metal-to-metal end-contact which, when installed in a well or socket, gives a speed of response unsurpassed by any other similarly protected temperature-sensitive element. Exceptionally rugged and permanent in calibration.

These are only a few of the important advantages of this better temperature measuring system . . . available also for control of temperatures, or with Multi-Record Dynalog Recorder for up-to-6 records on one chart. Write for illustrated bulletins, The Foxboro Company, 464 Neponset Ave., Foxboro, Mass., U.S.A.

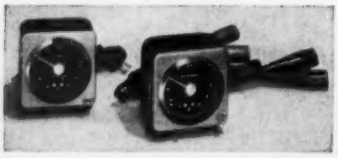
for any range between -100° and +600°F.



FOXBORO REG U S PAT OFF **INSTRUMENTATION**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **46** on inquiry card.



hp. power or less; (2) 230-v. 60-cycle for large commercial installations. 24-hour dials with 15-min. division. White hairline pointer indicates total elapsed time; bright red pointer indicates total running time.—*James P. Marsh Corp., Skokie, Illinois.*

For more information circle **231** on inquiry card.

Proximity Relay System for Tachometry, Counting, etc.

New "Model 4900" proximity pick-up impulse generator (low-speed complement to maker's "Model 3010A" magnetic pickup) can be excited by magnetic or nonmagnetic metals. With suitable auxiliary equipment, it may be used to indicate mechanical or electrical counting, position, rate of travel, sequence, frequency, etc., involving moving metal components. Pickup is connected by a ten-foot cable to "control unit" containing power supply and other components. System produces a d-c. voltage of constant amplitude when any metallic mass is brought near pickup. Voltage remains constant as exciting metal is within ⅛-in. and drops to zero when it is removed. Rise and decay times are extremely fast, producing snap action. Maximum rate over 12,000 events per minute.—*Electro Products Labs., Inc.,* 4501 *Ravenswood Ave., Chicago* 40, *Ill.*

For more information circle **232** on inquiry card.

Repeat Cycle Timers

New "Model 2" and "Model 3" repeat-cycle electronic timers provide on-cycles from 0.01 to 150 seconds and off-cycles from 0.01 to 900 seconds.

They utilize one radio type tube and a voltage regulator to charge two resistance-capacitance networks. During operation, one cycle automatically initiates the next without moving parts or external operation.—*G. C. Wilson & Co.,* 1950 *Eighth Ave., Huntington, W. Va.*

For more information circle **233** on inquiry card.

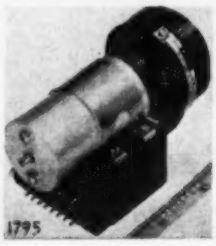
Long-range Pulse Timer

New "Long Range Pulse Timer" has a unique arrangement of cams rotating at different speeds to provide accurate momentary pulses even when spaced considerably apart in respect to time. Pulses occur regularly at factory pre-set intervals; frequency from 1 pulse every 15 seconds to 1 pulse per week.—*Hagen Mfg. Co., Inc.,* 202 *Twentieth St., Moline, Ill.*

For more information circle **234** on inquiry card.

Motor-driven Commutator

New "Model 85562" multi-channel motor-driven telemetering commutator, for radio and wired telemetering, automatic programming, sampling and monitoring, etc., has improvements including rhodium-plated printed circuits to meet individual customer requirements and higher speed: up to 1800 contacts per second. Switching can be break-before-make or make-before-break, with a phase adjustment on two-pole model; contact cleaning system that keeps switch free of noise throughout design life. Choice of two drives with gear reducers: a constant-speed governor-controlled motor, or a variable-speed motor whose speed varies linearly with applied voltage. Rated voltage of both drives is 24 to 29 v.d.c.—*G. M. Giannini,* 39 *Main St., East Orange, N. J.*



For more information circle **235** on inquiry card.

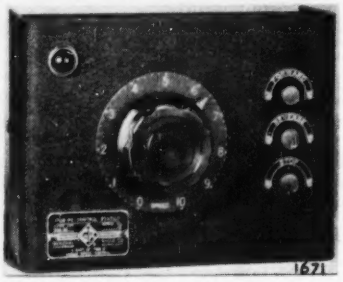
Non-repeat Timer Feature

New non-repeat feature increases usefulness of maker's "Electronic Timer" in many short-interval timing operations. Timer will operate without danger of repeating, either when started by a momentary contact or by a contact that exceeds duration of timed cycle. Timer does not reset automatically until after start switch is released.—*Farmer Electric Co.,* 21 *Mossfield Road, Waban* 68, *Mass.*

For more information circle **236** on inquiry card.

Motor Speed Controllers

New models of "Variac Motor Speed Controls" use same basic system of control as earlier units; make possible complete elimination of electron tubes or rotating machinery in operating d-c. motors from a-c. lines; can start motors slowly and smoothly (important for machines, lathes, etc.) and virtual elimination of torque pulsation is desirable in precision grinding, etc. Reversing of motor is obtainable in all models; dynamic braking in all but smallest (1/15 hp).—*General Radio Co.,* 275 *Massachusetts Ave., Cambridge* 39, *Mass.*



For more information circle **237** on inquiry card.

Incremental Counter

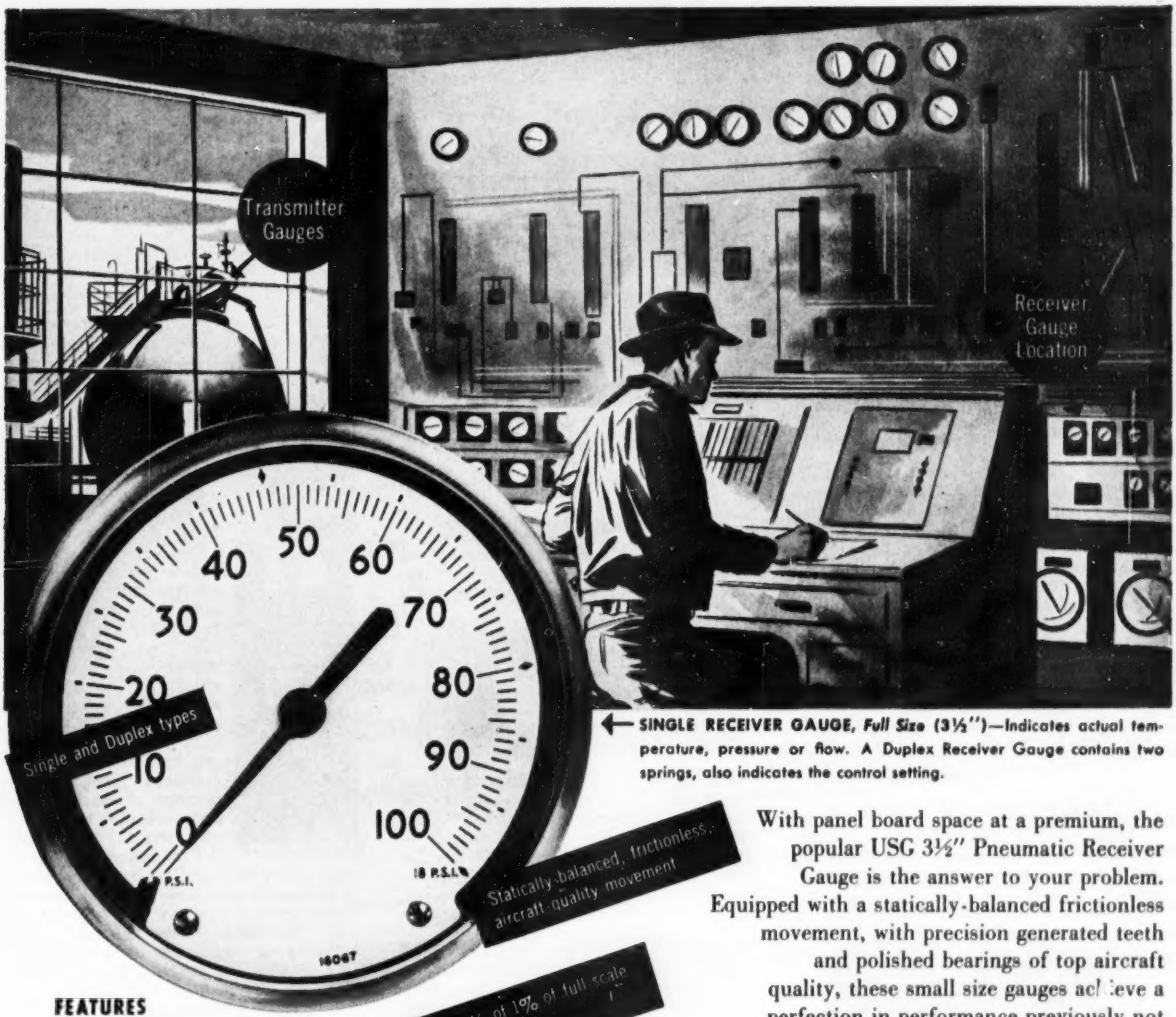
New "Model 3-Y-8382 Direct Reading Counter" indicates increments of measurement in navigating and directional instruments. Unit wheel has five divisions per digit which, combined with white indicator line on cover, makes for easy reading. Speeds up to 1500 rpm. (150,000 increments per minute).—*Durant Mfg. Co.,* 1914 *N. Buffum St., Milwaukee* 1, *Wis.*

For more information circle **238** on inquiry card.

Four-decade Counter-type Frequency Meter

New "DS-660" said to offer "a number of improvements over instruments now being used for electrical and mechanical event-counting," will count and display from 20 to 100,000 events per second; derives its time base from 60-cps. line. Among features: manual

Read pressure, temperature or flow at a distance with USG Pneumatic Receiver Gauges



← **SINGLE RECEIVER GAUGE, *Full Size* (3½")**—Indicates actual temperature, pressure or flow. A Duplex Receiver Gauge contains two springs, also indicates the control setting.

With panel board space at a premium, the popular USG 3½" Pneumatic Receiver Gauge is the answer to your problem. Equipped with a statically-balanced frictionless movement, with precision generated teeth and polished bearings of top aircraft quality, these small size gauges achieve a perfection in performance previously not thought possible of a pressure gauge.

FEATURES

Ranges:	3 to 15 p.s.i.g. stocked, 3-18 p.s.i.g. also available.
Scale:	A variety of scales available.
Case Diam.:	3¾"
Bezel Opening:	3½"
Pressure Elements:	Phosphor Bronze, AAA width, stress-relieved.
Movement:	Aircraft quality — phosphor bronze and stainless steel.
Adjustments:	±1% maximum linearity adjustment with adjustable tip; micro-adjustable pointer permits rotation with respect to pinion for zero adjustment.
Stops:	Zero and over-range.
Case:	Drawn steel, black crinkled finish, bevelled glass.
Socket:	Extruded brass.

SINGLE OR DUPLEX TYPES—The USG Receiver Gauge is graduated to the same scale as the transmitter gauge yet operates at a very small pilot pressure. It is available with a single spring or double spring (Duplex Receiver Gauge).

GAUGES CARRIED IN STOCK—USG Receiver Gauges are stocked without dials in the range of 3-15 lbs. This permits easy assembly and quick shipment of gauges with dials calibrated to your choosing. Single-spring gauges are available in ¼" low male or center back connection. Duplex gauges are available in low back connection with ⅛" or ¼" male pipe thread and 5/16-28 tubing connection.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

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GOTHAM INSTRUMENTS AND AUTOBAR SYSTEMS

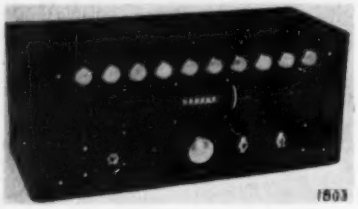
For more information circle **47** on inquiry card.

or automatic reset; self-checking; display from 1 to 10 seconds; new trouble-free decade plug-in units. Accessories (optional) include a tachometer pickup and photocell. Additional decade units to increase count capacity also available in standard units.—*The Detectron Corp., 5420 Vineland Ave., No. Hollywood, Calif.*

For more information circle **239** on inquiry card.

Electronic Counter

New "Model RC" direct-readout cold-cathode electronic counter operates at speeds up to 10,000 counts per

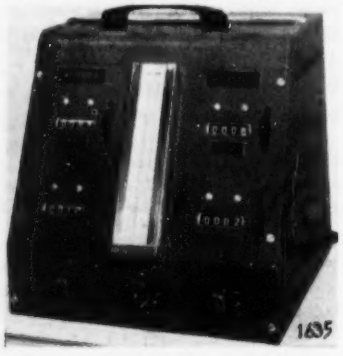


minute, functions from practically any pickup; consists of one electronic decimal unit displaying large digits, preceding a six-digit electromagnetic register; features: (1) cold-cathode electronic tube circuitry throughout, assuring long life and dependability; (2) complete independence from line voltage variations and fluctuations; (3) illumination of direct-reading decimal scale derived directly from associated cold-cathode tubes rather than from auxiliary light circuit.—*Haledy Electronics Co., 57 William St., New York 5, N. Y.*

For more information circle **240** on inquiry card.

Quality-control Counter

New "QauliCount" tells at a glance whether any process is "in control" or "out of control." Inspector pushes either "accept" or "reject" button at base as he checks each characteristic.



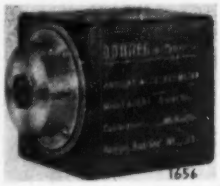
Accepted and rejected production are each shown on two counters. Upper accept and reject counters are set at start of shift, day, or week, and lower counters are reset at beginning of shorter, more recent periods. In center receptacle are a series of charts for different over-all average defective rates. Charts can be made up to suit. Instrument may be remote-actuated. Charts are washable vinyl plastic.—*American Hydromath Corp., 25-20 43rd Ave., Long Island City 1, N. Y.*

For more information circle **241** on inquiry card.

ACCELERATION

Linear or Angular Acceleration Pickups

New acceleration pickups measures linear or angular acceleration to four significant figures; incorporate



a vest-pocket servo system which automatically generates a current to counterbalance torque arising from acceleration. Voltage output of 10 volts or more per *G* is proportional to acceleration with approx. 0.1 percent over entire operating range, and goes precisely through zero at 0*G* without drift or hysteresis. Error due to friction has been measured as approx. 0.0002 *G.—Donner Scientific Co., 2829 Seventh St., Berkeley 10, Calif.*

For more information circle **242** on inquiry card.

Acceleration Pickup

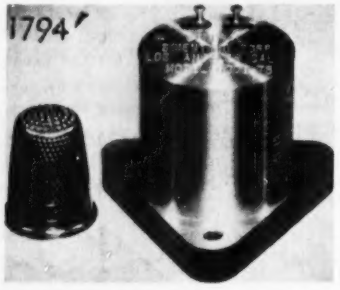
New "Sub-Subminiature Accelerometer" is of strain-wire type, is 1 in. long, weighs 14 grams (0.48 oz.); is

available in ranges of plus and minus 0.5 to 100 *G;* natural frequencies 30 to 250 cps. with damping 0.7 critical; accuracy 1 percent of full output.—*General Scientific Corp., 603 N. La Brea Ave., Los Angeles 36, Calif.*

For more information circle **243** on inquiry card.

Acceleration Pickup

New "Model 6000 Accelerometer" is of self-generating type, independent of external power supply requirements,



is available in ranges of plus and minus 0.25 to 100 *G;* frequency response 5 to 350 cps.; natural frequency 600 cps.; damping 0.5 critical; output 2 volts or better; impedance 1700 ohms (d-c. res.); temperature limits –50 F to 350 F. continuous and to 550 F. for 100 hours; transverse sensitivity less than 2 percent.—*General Scientific Corp., 603 N. La Brea Ave., Los Angeles 36, Calif.*

For more information circle **244** on inquiry card.

COMPUTING

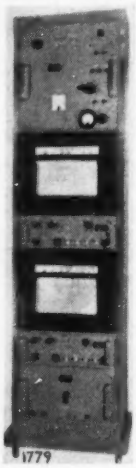
Printed Code Reader

New Printed Code Reader can be incorporated into computers and business machine systems; enables preprinted, pretyped, handwritten or hand-corrected code to feed directly into mechanized business systems as a substitute for keyboard input. Code is optically sensed from moving or stationary paper. Output signals can be fed directly into magnetic tape or drum, punch card, and punch tape systems.—*The Kybernetes Corp., 1108 Raymond Blvd., Newark 5, N. J.*

For more information circle **245** on inquiry card.

Automatic Wave Analyzer

New "Series 901" is a heterodyne-type wave analyzer for reducing vibration, seismic, power-line transient, noise, shock, and similar data automatically. Analysis is Fourier: amplitude vs. frequency. Depending upon repetition rate, an amplitude vs. time plot for a given frequency can be provided. Analyzer is suited for operation from repetitive-signal source such as a magnetic tape loop; covers frequency range of 3 to 2000 cps. Among features; variable bandwidth 0.5 to 45 cps.; analysis down to 3 cps.; amplitude accuracy 5 percent of reading on logarithmic scale; frequency accuracy 0.5 percent of reading; input voltage range 60 db; input impedance 2.5 megohms. Up to 14 inputs handled and selected completely automatically, including if desired simultaneous analysis of 2 to 14 inputs. Six basic units available individually as well as in assembly.—*The Davies Labs., Inc., 4705 Queensbury Rd, Riverdale, Md.*

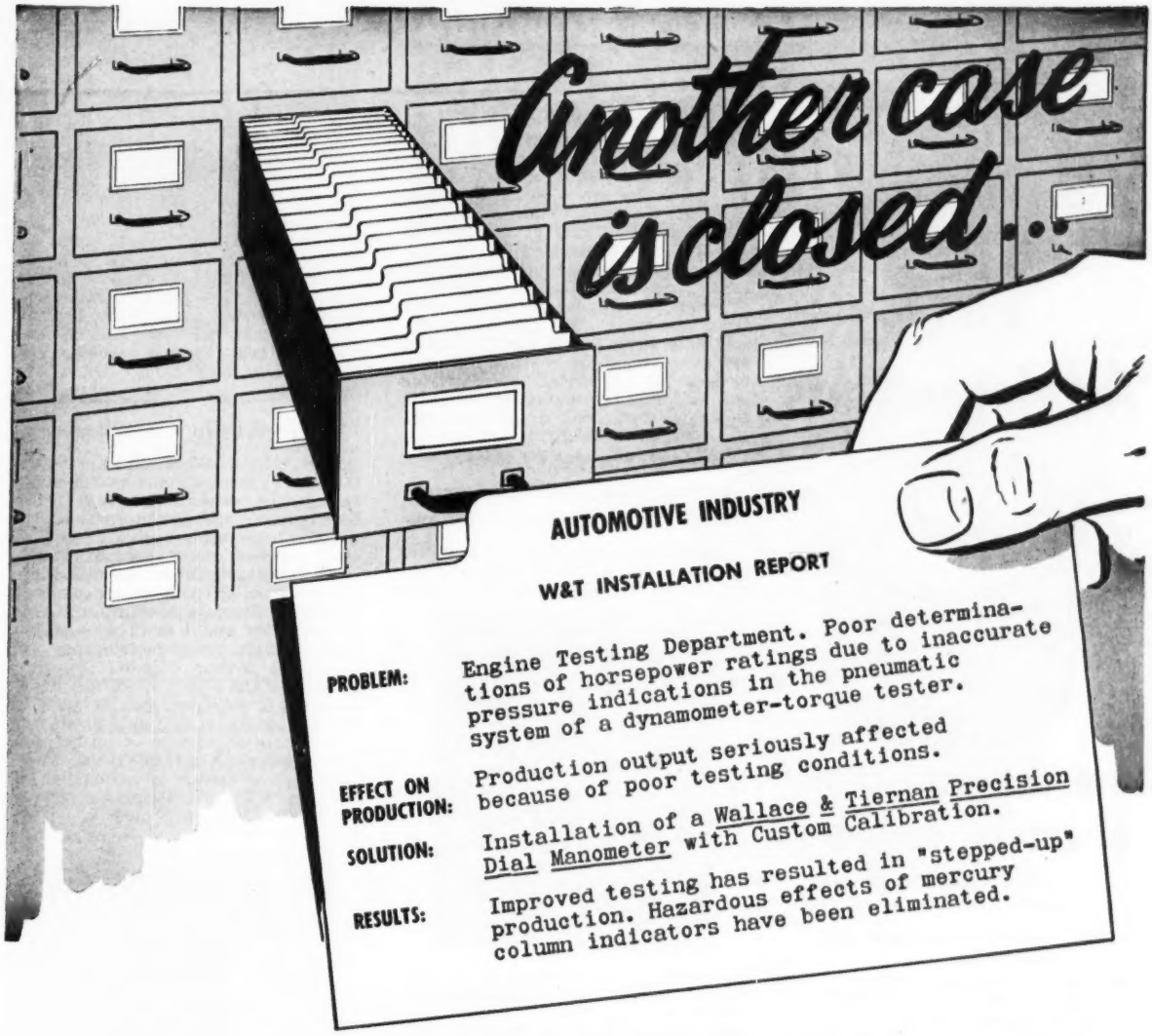


For more information circle **246** on inquiry card.

Digital Computer

New "Digital Differential Analyzer" is said to be a "high-speed moderately-priced electronic computer character-

ized by simplicity of operation and unusual mathematical versatility." Fundamental operation is numerical integration of any variable with re-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For more information circle **49** on inquiry card.

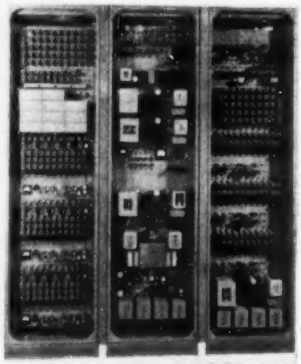
NEW INSTRUMENTS

spect to any other variable (linear or non-linear) which generates a third variable. Integrators may also be coded to perform addition, multiplication, division, comparison, limiting, decision, and servo operations. Capacity, 60 integrators; normal speed, 100 iterations per second. (Should a problem require 30 integrators or fewer, iteration rate of independent variable may be doubled to 200 ips.) Automatic programming by punched tape prepared by electric typewriter, or computer may be manually coded from monitor control panel. Decimal solutions displayed in both tabulated and graphical form. Solution data can be recorded on punched tape for later use in other computations.—*Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.*

For more information circle **247** on inquriy card.

Analog-to-digital Converter and Transmission Systems

New analog-to-digital electronic data conversion system originally designed for military use, is suitable

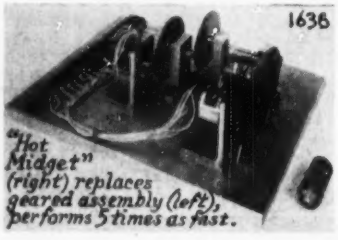


for industrial use because of its ability to transmit data under adverse conditions (e.g. from a remote location over ordinary telephone or radio circuits) with imperceptible loss of original accuracy. System will accept d-c. data from three separate sources and encode them. At receiving end, equipment separates code numbers and re-converts codes back to provide d-c. output voltages equal, within 100 mv., to d-c. input at transmitter.—*Electronic Engineering Co. of Calif., 180 S. Alvarado St., Los Angeles 57, Calif.*

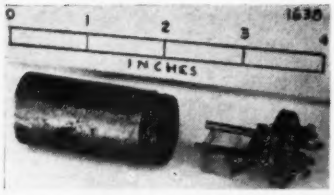
For more information circle **248** on inquiry card.

Thermal-type Components for Analog Computers

New component for analog computations performs operations of arithmetic, algebra, calculus, etc.; is of an entirely new type devoid of moving



"Hot Midget" (right) replaces geared assembly (left), performs 5 times as fast.



parts, operating by heat flow and with intrinsic function $f(x) = (k'x)/(1 + p\tau)$ where k' is an attenuation factor and τ a characteristic time—which may be as short as a few milliseconds in small units where heating and heated elements are minute filaments.—*Arma Corp., Roosevelt Field, Garden City, N.Y.*

For more information circle **249** on inquiry card.

Electronic Computer

New "Model 203 Electronic Digital Computer" is an all-purpose computer said to be moderately priced "for hundreds of organizations which previously have been unable to afford costly electronic computation." It employs an easily-understood binary-coded decimal system utilizing a combination series-parallel operation. Computation speed is thus increased over ordinary series instruments and numerical system simplifies programming and actual operation. Progress of a problem can be quickly checked by operator from a display of neon lights on console or on maintenance panel. New "203" stores information of either a permanent or temporary type in its memory unit, which is a 3600-rpm. magnetic drum

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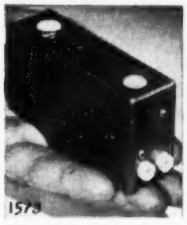
For more information circle **50** on inquiry card.

that can remember 4,080 ten-digit "words." Upon request from operator or computer's "command list," a word can be supplied from quick-access section of memory in 0.0085 sec. and from main part of memory drum in 0.085 sec. Additional auxiliary memory units will provide more than a million and a half words. Personnel having only limited technical skill may be employed at console after problems have been prepared by mathematicians. Maker trains customer personnel in programming, operation and maintenance.—*Consolidated Engineering Corp., Pasadena 8, Calif.*

For more information circle **250** on inquiry card.

NUCLEONICS

Pocket-size Counter



New Geiger counter, announced as "the world's smallest and lowest cost geiger counter," is said to be completely self-contained; provides continuous or intermittent service. Used in conjunction with earphones, it is designed as a Civil Defense aid for plant or office. Weight, 11 oz.—*Cam-Mac Div., Micro Specialties Co., 1834 University Ave., Berkeley 7, Calif.*

For more information circle **251** on inquiry card.

Area Monitoring System

New "RAMS-1" Remote Area Monitoring System is said to be usable "in many applications for which no

standard reasonably priced equipment has been previously available." Radioactivity measurements from background to as high as 100,000 R/hr. can be made in several steps from one to ten ionization chambers up to 5000 feet from control panel without need

BROAD BAND PULSESCOPE

by Waterman

MODEL S-6-A

DC CALIBRATION
MARKERS 1-1000 μs
0-5 mc

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22 Pounds

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The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size, and it compares more than favorably with oscilloscopes that are *transportable*, instead of portable. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative AC or DC signals. The scope uses a 3XP1 tube with 1500 volts on the second anode, thus providing a brilliant trace for high speed transients even at low repetition rates. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal intensity markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

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For more information circle **51** on inquiry card.

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For more information circle **53** on inquiry card.

NEW INSTRUMENTS

of high-voltage supply, vibrators, amplifiers, transformers and hi-meg resistors. Recorders and alarm devices are easily connected into system.—*Jordan Electronic Sales,* 119 *E. Union St., Pasadena* 1, *Calif.*

For more information circle **252** on inquiry card.

Gamma-ray Detector

New "Model 933 Scintillometer" is for geological survey work, radioactive ore assaying, civil defense rad-

ing in industry. It is said to be "290 iation monitoring and personnel training, general health-physics contamination monitoring, and isotope tractimes more sensitive than Geiger type counters."—*The Radiac Company, Inc.,* 489 *Fifth Ave., New York* 17, *N. Y.*

For more information circle **253** on inquiry card.

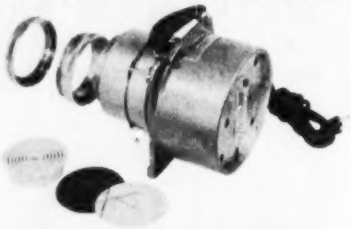
Alpha-radiation Detector

New "Alpha Poppy," designed to check work areas and clothing for sources of alpha radiation, will often be used with equipment that sends out warning "pops" when alpha contamination is detected; hence name. "Muzzle" of pistol-like device is passed close over suspected areas. Tissue-thin aluminum foil lets in alpha particles but keeps out ordinary light. Alphas strike a zinc sulphide screen, and resulting scintillations are converted to electrical impulses which are amplified to obtain an audible or visible signal.—*General Electric Co., Schenectady* 5, *N.Y.*

For more information circle **254** on inquiry card.

High-volume Air Sampler

New "High Volume Air Sampler" (developed in labs of New York Office



of AEC) employs a turbine type blower; is designed for 24-hr air sampling.—*The Staplex Co.,* 794 *Fifth Ave., Brooklyn* 32, *N. Y.*

For more information circle **255** on inquiry card.

ohmart solves tough control problems with radioactivity

Here's a typical Ohmart installation—to control the draining off of the heavy material in a tank after separation of a heavy and light materials mixture. The Ohmart Density Gauge detects the interface level as it reaches the desired point, shuts off the flow automatically! Ohmart Density Gauges are performing many other measurement and control tasks throughout industry, involving liquids, slurries, sludges, in difficult and "hidden" processes . . . wherever density is a function of the desired measurement. Basis of all Ohmart instruments are Ohmart Cells, which convert radioactive energy directly into electrical energy.

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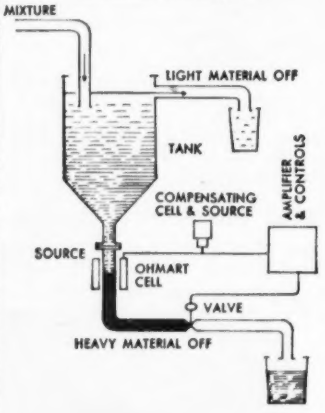
We invite your inquiry.



Electricity From Radioactivity

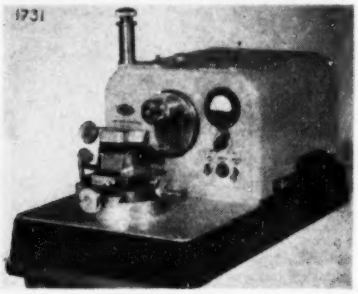
the ohmart corp.
Department S-16
2236 BOGEN STREET
CINCINNATI 14, OHIO

For more information circle **54** on inquiry card.

LABORATORY INSTRUMENTS

Ultra-microtome

New "Sjostrand Ultra-Microtome" (made in Sweden) has been specially designed for sectioning electron microscope samples. Sections as thin as



100 to 200 A.u. are obtainable. Knife is an ordinary razor blade with specially polished edge. Cutting speed is 60 sections per minute.—*Ivan Sorvall, Inc.*, 210 *Fifth Ave., New York* 10, *N. Y.*

For more information circle **256** on inquiry card.

Incubator

New model of "Precision-Freas B.O.D. Incubator" affords closer temperature control and greater uniformity during low-temperature incubations; has a range of 5 to 50 C., and forced circulation. Higher accuracy (0.5 C.) derives from a sensitive hydraulic thermostat and use of a heating coil to stabilize cooling cycle when operating near room temperature. Three shelves provide 8-½ sq. ft. of working area, with additional space on two shelves built into door. Self-defrosting cabinet, 24x17x32 in. high inside, holds up to 10 percent more B.O.D. bottles than older models.—*Precision Scientific Co.*, 3737 *W. Cortland St., Chicago* 47, *Ill.*

For more information circle **257** on inquiry card.

Beaker Grip

New "Beekur-Grip" facilitates rapid, safe handling of beakers, as in descending-type chromatographic apparatus containing corrosive or irritating solvents; features novel remote-control (in handle top) spring tension grips; accommodates 50-250 ml. beakers. Built-in platform acts, in operation, to prevent contamination and spillage.—*The Nalge Co.*, 625 *S. Goodman St., Rochester* 20, *N. Y.*

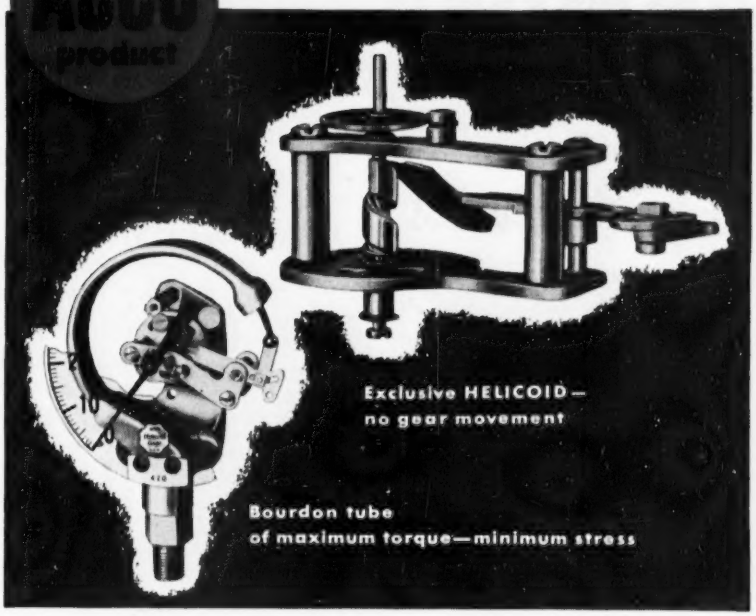
For more information circle **258** on inquiry card.

Water-hardness Tester

New "Speedy-Kit" permits making field tests of water hardness sensitive to one grain per gallon (17.1 ppm.) in one minute. A sample of water is measured into a marked glass vial;

an ACCO product

Helicoid Gages



Why HELICOID Costs Less Per Gage, Per Year

HELICOID Gages have many unique and exclusive features which result in enduring accuracy and savings in maintenance cost. They cost less per gage, per year.

Only HELICOID Gages, for instance, have the Helicoid Movement . . . a simple cam and roller design which has no gear teeth to wear out. Bourdon tubes used in HELICOID Gages are carefully designed to give maximum torque and minimum stress . . . promoting the greatest possible endurance life. They withstand many millions of pressure pulsations without stretching, leaking or cracking.

There is a HELICOID long-life gage to meet every type of pressure control requirement. Pressure ranges to 20,000 psi, vacuum or compound. Dial sizes: 3½", 4½", 6", or 8½". Dials may be black, white or radiant faces. They are supplied for wall or stem mounting, flush or panel mounting, or flangeless.

All HELICOID Gages are fully guaranteed. They are time-tested and proved in years of hard service. They assure the highest degree of gage accuracy and long-life service.

Write **TODAY** *for the* **G-2 HELICOID Gage Catalog**

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

927 Connecticut Avenue • Bridgeport 2, Connecticut

For more information circle **55** on inquiry card.

DAVIS

Continuous combustible gas alarm systems

REMOTE HEAD
AND TUBE SAMPLING TYPES

A complete line of Davis Gas Alarm Systems, together with a number of accessories, is available to meet varying requirements in protecting life, property, and processes against the explosive hazards of combustible gases and vapors in air.

They function by means of automatic continuous sampling of the flammable gas-air mixture, and give audible and visual signals when the gas concentration approaches dangerous limits.

Davis also offers special equipment designed to meet particular requirements or applications.

For complete information, write for Technical Bulletin 11-36.

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS
A Division of Davis Emergency Equipment Co., Inc.
80 Halleck Street
Newark, N. J.
Progressive Manufacturers of Gas Analysis Instruments

For more information circle **56** on inquiry card.

NEW INSTRUMENTS

two drops of "Solution A" are added from a bottle, turning water red. "Solution B" from a second bottle then is added one drop at a time, until red changes to blue. Each drop of "B" used represents one grain per gallon of hardness, as calcium carbonate. "Speedy-Kit" is pocket-size, weighs 6 oz. Reagents suffice for 50 to 100 tests, depending on water hardness.—*Calgon, Inc., Hagan Corp., or Buromin Co., P.O. Box* 1346, *Pittsburgh* 30, *Pa.*

For more information circle **259** on inquiry card.

High Vacuum System for Electron Microscopes

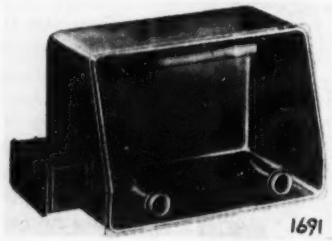
1678

New high vacuum system will pump down a 12-in. bell jar to 0.04 micron in 3 minutes; this is made possible by pumping speed of 260 lps. of diffusion pump and 5 cfm. of mechanical pump. System includes all gages, pumps, by-pass line, and power supply. A double right-angle baffle prevents back-streaming oil from reaching bell jar.—*High Vacuum Equipment Corp., Hingham, Mass.*

For more information circle **260** on inquiry card.

Controlled-atmosphere Hood

New lightweight portable controlled atmosphere hood creates a completely dry, sterile, inert and dust free atmosphere; is constructed of a new chemically-inert fibre-glass plastic


1691

material. Unique filter system with vacuum or pump allows operator to select purification trains. Hood can be readily equipped with attachments such as UV lamps, filter controls, vacuum pumps, neoprene gloves, etc. —*P. M. Lennard Co., Inc.*, 671 *Bergen St., Brooklyn* 17, *N. Y.*

For more information circle **261** on inquiry card.

Diffusion-pump Oil

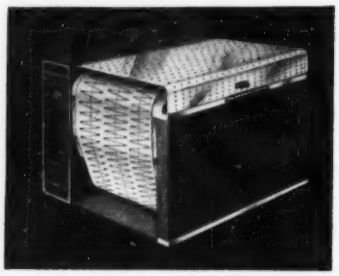
New "Cencoil-B" for use in diffusion and fractionating pumps is a distilled-in-glass di-2-ethyl hexylphthalate. When used in single-stage non-fractionating diffusion pump it produces a vacuum of 7×10^{-6} mm. Hg at 25 C. without a liquid air charcoal trap.—*Central Scientific Co.*, 1700 *Irving Park Blvd., Chicago, Ill.*

For more information circle **262** on inquiry card.

PHOTOGRAPHY, etc.

Oscillogram Developer

New oscillogram developer can develop and dry photosensitive paper at speeds up to 12 fpm.; is semi-portable; can be operated by personnel not familiar with development technique; requires no wash process; operable in daylight; can process photosensitive paper up to 12 in. wide and 250 ft. long.—*Meter & Instrument Dep't, General Electric Co., West Lynn* 3, *Mass.*



For more information circle **263** on inquiry card.

Two-sided Copying Paper

New "Apeco Duplex Paper" permits photocopies to be made on both sides of a single sheet; has been designed to work with "Systematic Auto-Stat" one-unit dry photocopy machine: is made to handle letterhead, legal and book-page-size copies, as well as larger copies up to 11 in. wide, any length. No limitation as to type of paper, documents, etc., to be copied; and original may be on opaque or transparent paper.—*American Photocopy Equipment Co.*, 1920 *W. Peterson, Chicago, Ill.*

For more information circle **264** on inquiry card.

Contact-print Paper

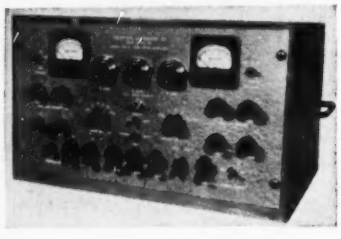
New "Kodagraph Contact Paper Translucent" is said to be an extra-translucent, extra-durable contact paper designed to give faster print back speeds when diazo or blueprint reproductions are made. Photographic lines on this paper can be erased with an ordinary pencil eraser after it is moistened slightly.—*Eastman Kodak Co., Rochester* 4, *N. Y.*

For more information circle **265** on inquiry card.

TESTING

Transistor Analyzer

New "Model TA-2 Transistor Analyzer" is a negative-resistance and characteristic-curve tracer for use with a laboratory type 'scope, which will trace all negative resistance curves of both *n*-type and *p*-type point-



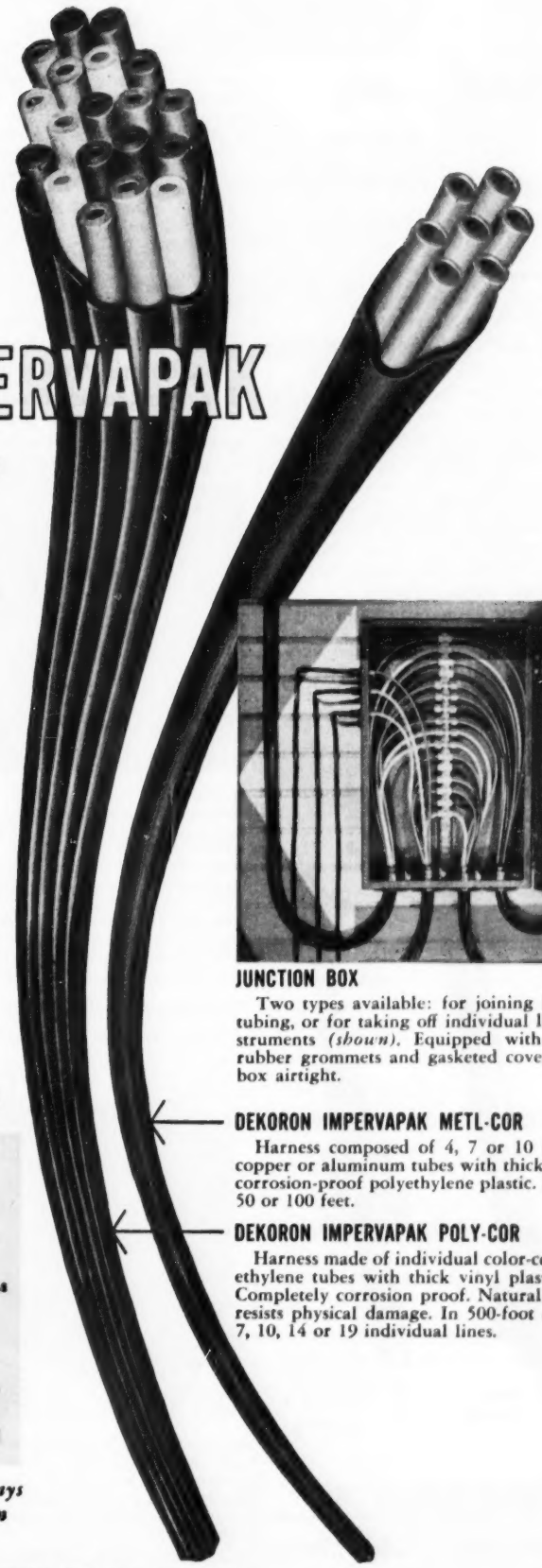
DEKORON IMPERVAPAK

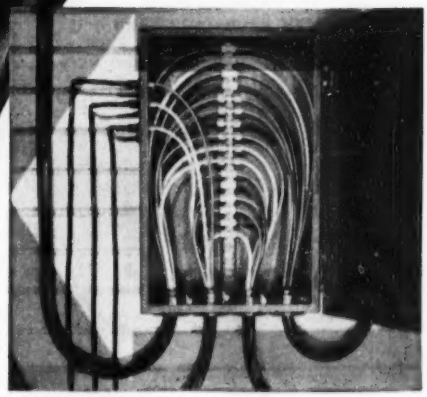
the instrument line harness that cuts tubing installation costs up to 50%

Worried about high instrument tubing installation costs? Then Dekoron Impervapak—the *corrosion-proof* instrument tubing harness—is just what the cost analyst ordered.

With Dekoron Impervapak there's no need to laboriously install instrument lines one at a time. Users say seven-tube Impervapak harness can be installed as rapidly as two single lines of ordinary instrument tubing. Savings are correspondingly greater with 10, 14 or 19-tube harness. Compact construction makes the installation neat and less subject to mechanical damage; no special brackets are needed.

And perhaps most important of all, *Dekoron Impervapak is impervious to attack from even the most severe industrial atmospheres or weather conditions.*





JUNCTION BOX

Two types available: for joining lengths of tubing, or for taking off individual lines to instruments *(shown)*. Equipped with synthetic rubber grommets and gasketed cover to make box airtight.

DEKORON IMPERVAPAK METL-COR

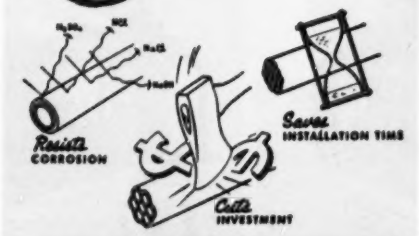
Harness composed of 4, 7 or 10 individual copper or aluminum tubes with thick sheath of corrosion-proof polyethylene plastic. In coils of 50 or 100 feet.

DEKORON IMPERVAPAK POLY-COR

Harness made of individual color-coded polyethylene tubes with thick vinyl plastic sheath. Completely corrosion proof. Natural resiliency resists physical damage. In 500-foot coils of 4, 7, 10, 14 or 19 individual lines.

A-6430

Dekoron® tubing



SAMUEL MOORE & COMPANY
DEKORON TUBING DIVISION • MANTUA, OHIO

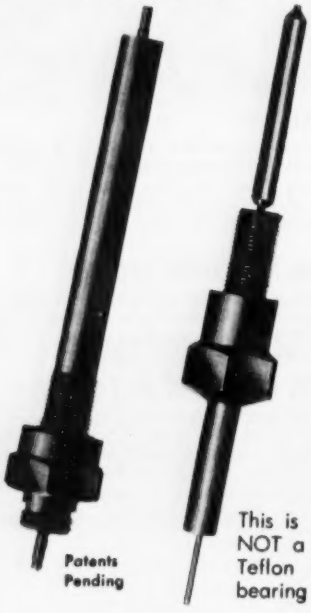
Send for your free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."

For more information circle **57** on inquiry card.

stop costly meter bearing replacement

- The price of one IIC Non-Freezing, Stainless Steel Bearing becomes your entire bearing cost.
- Many plants have had hundreds in use 3 to 5 years without service.
- Proved in the field for many years under the most severe operating conditions in all types of mercury flow meters and controllers, the advance-design IIC bearing is the answer to leaking, freezing, friction and corrosion. The IIC Instrument Bearing requires no lubrication—ever! Friction is reduced to the minimum, remains constant at high pressures. Requires no shaft end thrust, no adjustment. Installation is simple.
- The IIC bearing is manufactured as replacement for Brown, Emco, Foxboro and Metric meters and for many other special applications.
- WARRANTY: IIC Non-Freezing Bearings are guaranteed to give satisfactory service.

Write for Bulletin 52-R



INDUSTRIAL INSTRUMENT CORP.
Box 1909 Odessa, Texas

Circle **58** on inquiry card.

NEW INSTRUMENTS

contact transistors. Since all circuit parameters controlling negative resistance curves are available as measurables on front panel, "Model TA-2" enables user to visually design any negative resistance circuit around a given transistor in a matter of minutes, and to determine applicability of any transistor in a given negative-resistance circuit. It will also trace collector characteristics R_{22} for both grounded emitter and grounded base connections, and transfer characteris- contact transistors and *n-p-n* and *p-n-p* junction transistors.—*Polyphase* tic R_{12} of *n*-type and *p*-type point *Instrument Co., Bryn Mawr, Penna.*

For more information circle **266** on inquiry card.

Automatic Tester-Grader for Electronic Components

New equipment for complete automatic testing and sorting of electrical components performs high-voltage

breakdown tests between leads, between leads and can, and then sorts components by predetermined tolerances in up to eight categories. Equipment consists of "Auto-Bridge" breakdown tester and an automatic air-operated sorting wheel; is so synchronized that unskilled labor may operate it.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **267** on inquiry card.

Furnace-atmosphere Tester

New portable visual unit enables operator to determine, quickly and easily, quality of gas being produced

by a special atmosphere generator, also quality of atmosphere in special-atmosphere heat-processing furnaces. Complete unit weighs approx. 35 lbs. —*The Electric Furnace Co., Salem, Ohio.*

For more information circle **268** on inquiry card.

Insulation Tester

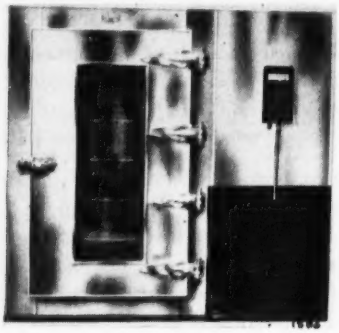
New "Model 226" of maker's "Vibrotest" provides essentially constant d-c. test voltage, independent of ohmic

value being measured; is built for hard industrial usage. New circuit uses no vacuum tubes and is designed around a synchronous vibrator power supply with maximum output current of 400 microamperes at 500 v.dc. Megohm ranges are 1-100 and 1-1000.—*Associated Research, Inc., 3767 W. Belmont Ave., Chicago 18, Ill.*

For more information circle **269** on inquiry card.

Large Test Chamber

New "Model A-30-40FH" test chamber has 30 cu. ft. capacity. Features include visible type controller, unique heat exchangers and multi-

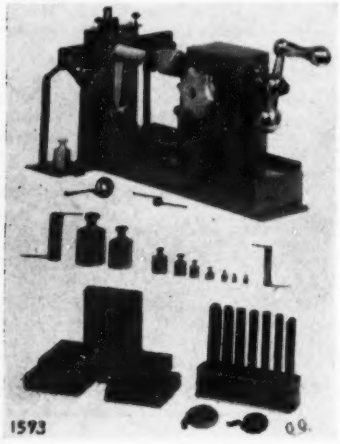


paned visual port and apertures for connections to inner chamber. Temperature range to –40 F. on refrigeration cycle and to 200 F. on heat cycle. —*Dep't 469, Webber Mfg. Co., Inc., 2740 Madison Avenue, Indianapolis 3, Ind.*

For more information circle **270** on inquiry card.

Torsion Spring Tester

New Universal Tester, first of its kind commercially available, checks loads and deflections of torsion, double torsion, spiral, clock and power springs; is useful for general-purpose testing but can be used for produc-



SANBORN 150 SERIES
OSCILLOGRAPHIC RECORDERS

The BASIC four-channel assembly includes: Cabinet, Recorder, and, for each channel, a BUILT-IN unit (A), which comprises a Driver Amplifier with frame, and a Power Supply with control panel.

A NEW design concept that brings even greater versatility to industrial OSCILLOGRAPHIC RECORDING

You have a CHOICE of readily interchangeable, plug-in Preamplifiers (B) for EACH channel, as described below.

The new Sanborn 150 Series offers greater operating efficiency and convenience, and encompasses a *variety of uses* which include the accurate recording of almost every phenomenon whose frequency spectrum lies in the range from 0 to 100 cycles per second.

A *wide selection* of plug-in preamplifiers, or "front end" units, such as (B) above, are completely interchangeable in any or all channels of the 150 Series amplifier section, where they simply plug in to the driver amplifier and power supply, (A) above, which are already in place.

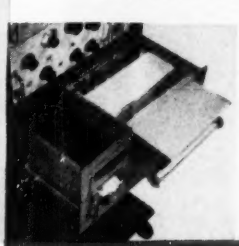
Available plug-in Preamplifiers include: AC-DC, CARRIER, SERVO-MONITOR, DC COUPLING, LOG-AUDIO, and LOW LEVEL. Blank plug-in assemblies are also available for users to make input circuits for special measurement problems.

And, there are the popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

A new catalog on Sanborn Oscillographic Recording Systems and their components will be sent gladly on request.

OTHER SANBORN IMPROVEMENTS

- **Extended frequency response.**
- **Improved regulated power supply.**
- **Individual stylus temperature control for EACH channel.**
- **Improved, single control, paper speed selector. Nine speeds — 0.25 to 100 mm/sec.**
- **Recorder slides out, if desired, for better view of recorded events, or for notations on record (illustrated at right).**
- **Improved control of input signals by use of 1, 2, 5 ratios on attenuator.**



SANBORN COMPANY
INDUSTRIAL DIVISION

195 MASSACHUSETTS AVENUE
CAMBRIDGE 39, MASS.

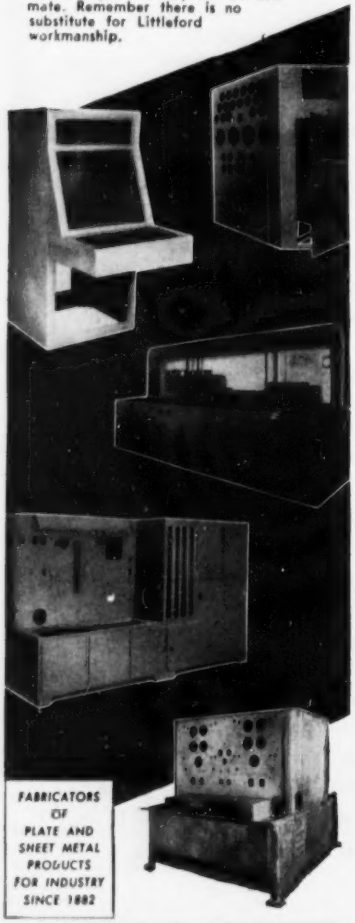
For more information circle **59** on inquiry card.

LITTLEFORD

CABINETS • • • and PANEL BOARDS

Accurate fabrication of Cabinets, Panel Boards, Cubicles and Control Panels comes from years of experience in shearing bending, forming, welding and finishing all types of metals. Since 1882 Littleford has been serving industry in producing accurate fabrication.

These long years of producing fabricated products reflect in the finished unit. Littleford facilities are modern and afford an unprecedented standard of dependability and quality. If you have a problem involving accurate fabrication be assured Littleford skill and experience will produce the best possible product at low cost. Send blueprints today for an estimate. Remember there is no substitute for Littleford workmanship.



FABRICATORS OF PLATE AND SHEET METAL PRODUCTS FOR INDUSTRY SINCE 1882

LITTLEFORD

LITTLEFORD BROS., INC.
404 E. Pearl Street, Cincinnati 2, Ohio

Circle **60** on inquiry card.

NEW INSTRUMENTS

tion testing of torque and angular travel at rates of 300 to 600 tests per hour; meets NBS requirements for precision scales and is guaranteed accurate within 0.25 percent. Capacity: Torsion springs having wire diam. from 0.005 in. to 0.125 in., outside diam. from 1/16 in. to 6 in., lengths from 1/16 in. to 6 in., can be tested for torque from ¼ in.-oz. to 48 in.-lbs. Accessories: 15 arbors, set of weights, adapters for extremely small springs. —*The Carlson Co., 277 Broadway, New York 7, N. Y.*

For more information circle **271** on inquiry card.

Curve-displaying Tester

New "Visual Vacuum Tube Tester" displays on a cathode-ray screen a family of I_P/E_P curves for any receiving type thermionic tube. In all, eleven such curves are presented at one time. In addition to automatized visual presentation of dynamic performance, static tests can also be carried out. A number of variable supplies are provided, with whose aid I_P/E_P, I_P/E_S, I_P/E_G, characteristics and others can be plotted. Tubes can be tested under pulse conditions. Nine standard tube bases are provided. Any electrode can be connected to any supply. Equipment comprises many interrelated units and an interlock prevents damage to instrument.—*Dep't 1A, Marconi Instruments, Ltd., 23-25 Reaver St., New York 4, N. Y.*

For more information circle **272** on inquiry card.

Testing-machine Calibrator

New "SR-4 Calibration Kit," for calibrating and proving testing machines and other measuring equipment, comprises a null-balance indicator and a set of calibration load cells

available in 11 capacities ranging from 60 to 120,000 lbs. for loads in tension or compression, or both, and in four capacities from 24,000 to 240,000 lbs. for compression loads only; meets ASTM E74-50P; is available with NBS Calibration Report. —*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **273** on inquiry card.

Porosity Tester

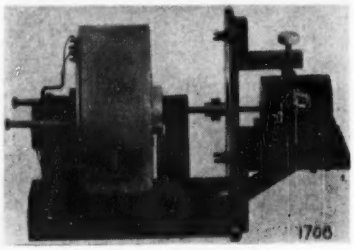
New model of "Permeometer," for measuring porosity or air permeability of materials too porous to be tested accurately or conveniently with a

densometer; measures air flow from less than 1 to about 400 cfm./sq. ft. at a pressure drop of 0.5 in. water.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle **274** on inquiry card.

Dynamometers

Two new "Dyna-Chek" dynamometers, for electric motors of 2 hp and less, are announced: "Model DM-3" measures hp, output of motors of 2 hp and less; "Model MDM" tests

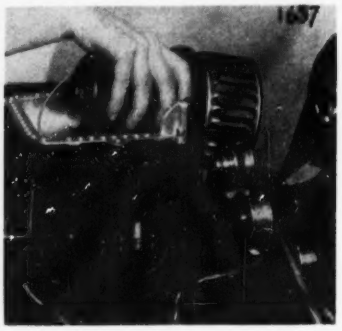


motors of less than 1/10 hp. Both models are provided with a special d-c. power supply. Two types of broad-range speed-measuring equipment are available as extra accessories: one provides accuracy to 2 percent, the other to 0.1 percent.—*Mission-Western Engineers, Inc., 132 W. Colorado, Pasadena 1, Calif.*

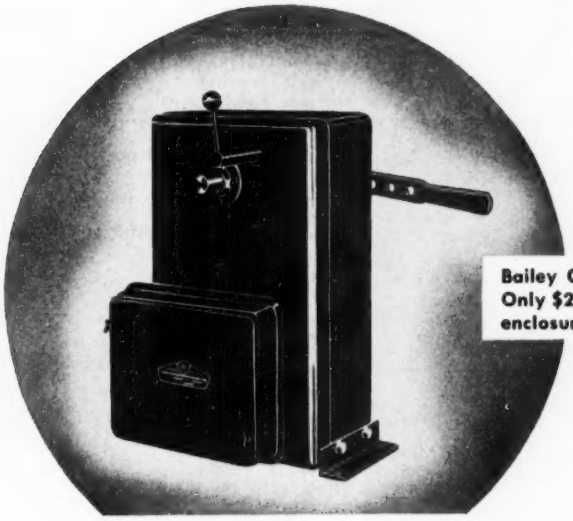
For more information circle **275** on inquiry card.

Balancing Machine

New "Model M2-S-44/U" is a special high-production type for balancing complete motor and blower wheel assemblies. A constant-speed belt drive arrangement automatically en-



gages under side of blower wheel as work is positioned and "gravity held"



Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

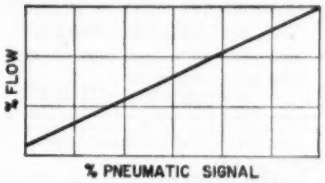
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

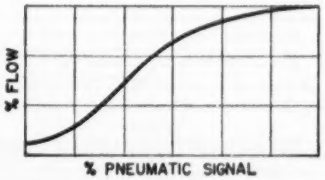
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-28

The New Bailey Control Drive gives you THIS—



instead of THIS



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Complete Controls for Process Plants

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Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
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☐ I am interested in Bailey Control Linkage. Mail me Spec. CA040B.

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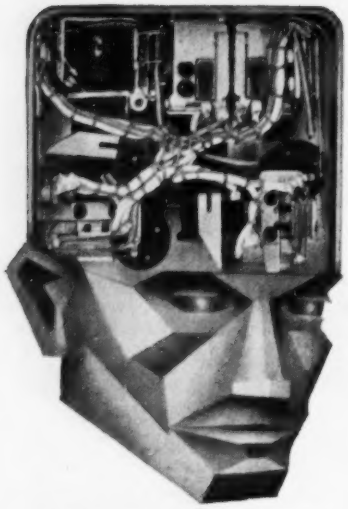
For more information circle **61** on inquiry card.



Brain Boxes
by Cook

Mass Producers of Electronic Intelligence for America's Aircraft, Guided Missiles, Armament, and Industry presents a winning combination

RELAYS – SENSING DEVICES
TIME DELAYS – FINE INSTRUMENTS
400 CYCLE COMPONENTS
and associated apparatus, developed and produced by the
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For more information circle **62** on inquiry card.

NEW INSTRUMENTS

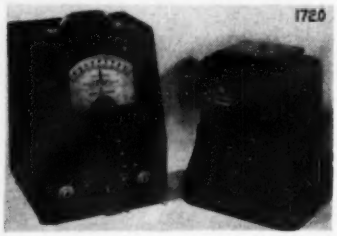
in rapid-loading fixture: no clamping necessary. Underdrive belt arrangement obviates need for belt handling or electrical connections, is adjustable for work from 2 in. to 8 in. in diameter. Rapid deceleration of work is accomplished by electrodynamic braking. Production speeds of 180 assemblies an hour are indicated.—*R. B. Annis Co., 1101 N. Delaware St., Indianapolis, Ind.*

For more information circle **276** on inquiry card.

DIMENSIONAL

Internal Comparator

New "Model D Electrolimit Universal Internal Comparator" checks internal diameters from 1/16 in. to ¼ in.; can also be used for checking

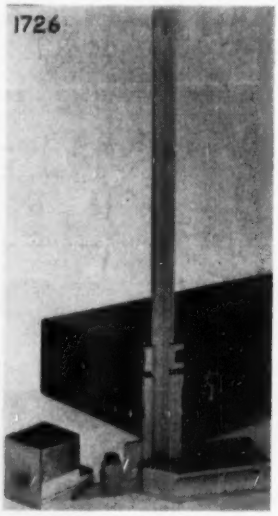


roundness and taper. "DDU Meter" has 4½-in. scale representing 0.001 in., with 20-microinch divisions.—*Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford 1, Conn.*

For more information circle **277** on inquiry card.

Height Gages

New height gages embody two improvements: (1) base slotted in front to allow short solid jaw with straight scribing point to reach down to surface plate, so that marking and read-



ing can start from bottom with vernier scale set to zero. (2) Vernier 2.450 in. long: 1/1000 in. with naked eye.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **278** on inquiry card.

Recording Gage

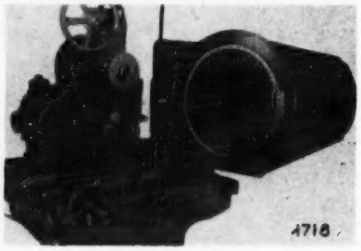
New "Talymin III" combines an electrical gage-head with "Talysurf" amplifier and recorder; features light

pressure and magnification variable from 100 to 5000; produces records of out-of-roundness, out-of-flatness, errors of gears (illustrated), cams, lead-screws, etc.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle **279** on inquiry card.

Projector-Comparator

New "Model OFG-200" projector-comparator (shown on a standard surface grinder) has been designed to be used both as an optical form

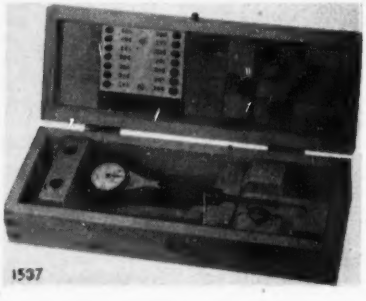


grinder projector and as a conventional universal type optical comparator. Its operation is simple: conventional grinder controls are used to develop most shapes and forms by following enlarged drawing on projection screen. When not thus used, it may be placed on a bench and used as a standard type optical comparator.—*Portman Instrument Company, Inc., Town Dock Rd., New Rochelle, N. Y.*

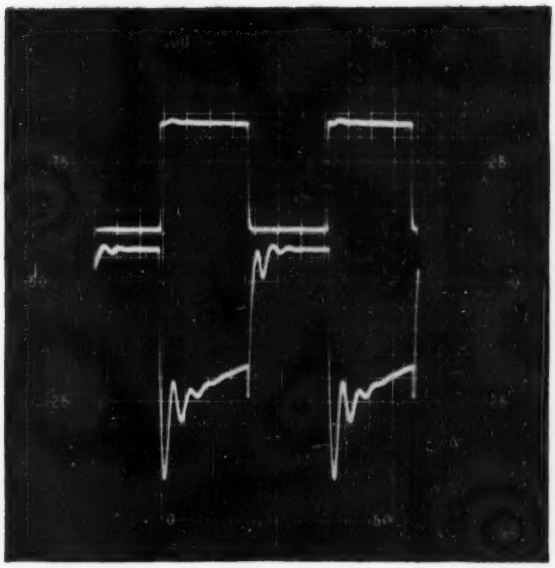
For more information circle **280** on inquiry card.

Dial Bore Gages

New small-size dial bore gages are announced. "Size #000" covers from ¼ in. down to 3/16 in.; "Size #0000" from 3/16 in. to ⅛ in. Like existing



Observe and Measure...



Grid and plate waveforms of amplifier are displayed on common time base for accurate comparison. Grid waveform (top) observed on 100 millivolts full scale; plate waveform (bottom) observed on 100 volts full scale. Illuminated calibrated scale facilitates both visual observation and analysis of oscillogram.

...with the new

DU MONT TYPE 322-A

Dual-Beam Cathode-ray Oscillograph

PRICE $895

Observe and *accurately measure* two signals simultaneously on a single cathode-ray tube screen with the new Du Mont Type 322-A Cathode-ray Oscillograph.

In addition to the well-known advantages of observing the true relationship between two signals on the same screen, Du Mont offers built-in, accurate amplitude calibration of each of the two channels in the new Type 322-A. Push-button calibration, plus an illuminated scale permit rapid, convenient, wide-range voltage readings of signals.

The accuracy achieved in the new calibration system of the Type 322-A results from the use of the newly developed Du Mont Type 5AFP- tight tolerance cathode-ray tube.

FEATURES

- **High-accuracy, dual-beam Type 5AFP- Cathode-Ray Tube.**
- **Essentially two complete time-tested Type 304-A cathode-ray voltmeters in one cabinet. Ranges of measurement from 100 millivolts full scale to 1000 volts full scale.**
- **Expansion to 5 times full scale vertically and 6 times full scale horizontally.**
- **Sweep ranges from 2 cps to 30 KC compatible with frequency range of d.c. to 10% down at 100 KC.**
- **New concentric knobs for easy manipulation and accurate resetting.**
- **Illumination of special calibrated scale can be varied for viewing and photography.**

DU MONT

for Oscillography

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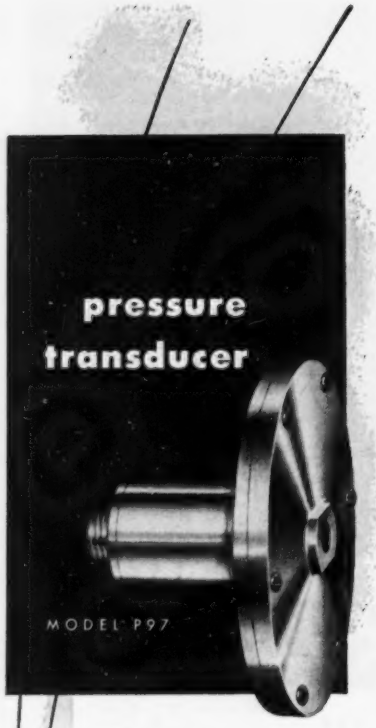
For more information circle 63 on inquiry card.



Differential or gage pressures in the range 0-0.05 psi are measured accurately and simply with the Model P97 pressure transducer.

The output of this instrument is 3.5 millivolts per volt full scale, permitting direct operation of a wide variety of commercially available recording, indicating, or controlling devices.

Pressure applied to the instrument is translated into an exact electrical equivalent by means of a full bridge transducer based on the unbonded strain wire principle.

Please request Bulletin No. 3.5.

Statham LABORATORIES
• Los Angeles 64, Calif.

For more information circle **64** on inquiry card.

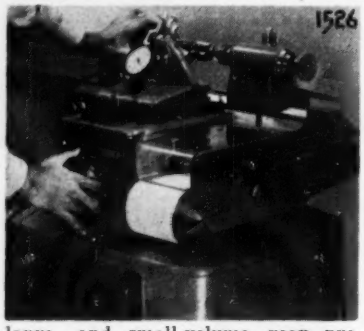
NEW INSTRUMENTS

model covering ⅜ in. to ¼ in., both employ centering-size disk principle whereby a removable disk of nearly bore size centers the head and serves as one of contacts. Each is being offered as either a "one-hole" gage to suit user's specified dimension and tolerance, or as a general-purpose gage for any dimension within overall range.—*Standard Gage Co., Inc., Poughkeepsie, N. Y.*

For more information circle **281** on inquiry card.

Gear-checking Recorder

New "Analytical Comparator" is a new type of gear checking machine, said to be "ideal for use by both



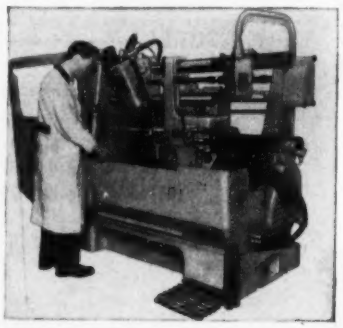
large- and small-volume gear producers." Chart record reveals all variations between a master gear and production gear being checked, is said to show condition of inspected surface better than is possible with numerical data alone.—*Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.*

For more information circle **282** on inquiry card.

MACHINE AUTOMATION

Automatic Copying Lathes

New models of automatic copying lathes are to be built in this country: by Industrial Metal Products Corp. of Lansing, Mich.; will conform com-



pletely to J.I.C. standards. (Undersigned company have previously imported their copying lathes from their parent company, H. Ernault Batignolles, France, pioneers in the field). New lathes, will do work with one or two tools which previously required as many as ten tools.—*H.E.B. Machine Tools, Inc., 475 Fifth Avenue, New York 17, N. Y.*

For more information circle **283** on inquiry card.

Engraving Machine

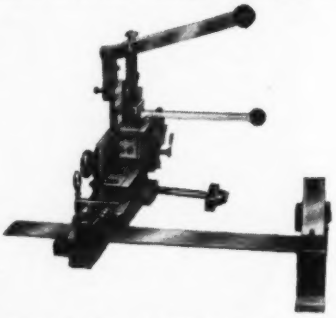
New "Model I-L" is a small (typewriter-size) engraving machine, with a portable chassis which may be lifted off its base and set directly onto work surface. It is claimed to be "the lowest cost engraving machine on the mar-

ket." An unskilled worker can turn out quality lettering "after a few minutes of practice." Fifteen different sizes may be engraved from one master letter. Automatic depth regulator has micrometer attachment.—*New Hermes Engraving Machine Corp., 13-19 University Place, New York 3, N. Y.*

For more information circle **284** on inquiry card.

Profile Tracers

New "Karge Profile-tracer Turnmat Machines and Lathe Attachments" are said to meet growing demand for turning long and slender parts involving multiple diameters and

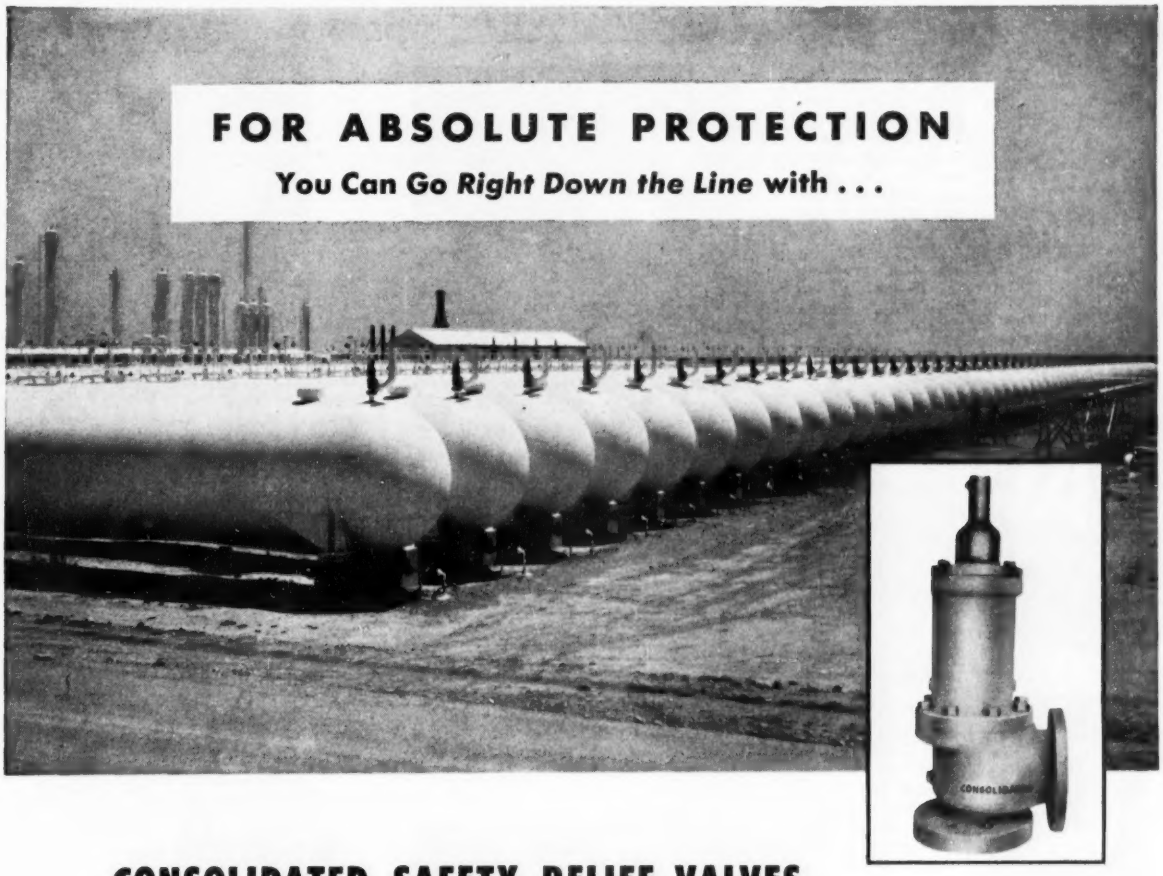


forms to close diameters and runout tolerances and requiring fine surface finishes. Basically, Karge turning technique differs from conventional bar turning practice in that bar stock itself is a driving link. Micro finish within tolerances of 0.0005 or better without use of follow rests, rollers, or bushings. Length of lathe bed, accuracy of lathe spindle or general condition of lathe or screw machine, of no importance.—*Turnomat Co., Inc., Brockport, N. Y.*

For more information circle **285** on inquiry card.

Parts Cleaning Machine

New model of "Industrial Precision Cleaning Machine" features an improved drying chamber with a thermostat which cuts off current to Chromalox heating unit if fan motor stops. New 1½-gal. jars are now being made of tempered glass to withstand rough



CONSOLIDATED SAFETY RELIEF VALVES

COMPLETE PROTECTION for personnel, property and equipment rates top priority in safety engineering wherever industry must confine gases, vapors and liquids in unfired pressure vessels. That is why Consolidated Safety Relief Valves are such a common sight on processing facilities, pipelines, pumps and storage tanks.

Consolidated Safety Relief Valves incorporate design and construction features that assure *dependable tightness* under the severest discharge piping stresses. Unfired pressure vessels are absolutely safeguarded against overpressures. No matter how tough the conditions of use, you can be sure of continuously reliable performance at the rated capacity.

SIMPLE DESIGN — 25% fewer parts than ordinary safety valves — means that Consolidated Safety Relief Valves minimize maintenance and standardization problems and save in long-life operation.

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MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **65** on inquiry card.

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

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Instruments

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Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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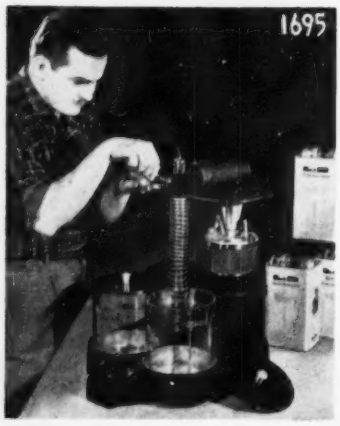
For more information circle **66** on inquiry card.

NEW INSTRUMENTS

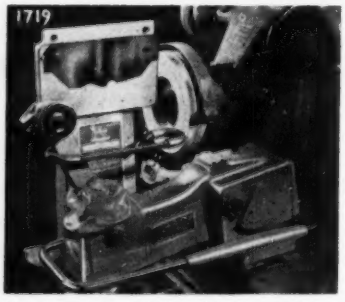


handling with much less chance of breakage. Jar covers are unbreakable. Among other features: maker's own 10:1 ratio ball-bearing gear-reduction motor; Monel mesh work basket which accommodates triple nesting baskets and permits three different kinds of small parts to be cleaned at the same time without risk of mixing.—*L & R Mfg. Co., 577 Elm St., Arlington, N. J.*

For more information circle **286** on inquiry card.

Grinding-wheel Former

New medium-sized "Diaform Wheel Forming Attachment" is designed to simplify form-truing of grinding



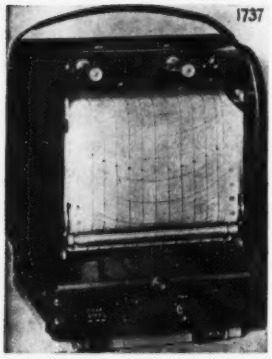
wheels up to 14 in. diam.; offers a method of truing a given form up to 2 in. wide and 1 in. deep in one setting. Basic construction is a vertical pantograph.—*Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford 1, Conn.*

For more information circle **287** on inquiry card.

ELECTRICAL INSTRUMENTS

Two-channel Recording Milliammeter

New "Dual Recording Milliammeter" has two independent channels and four selective chart speeds: 12 in./hr. to 12 in./min. Unique feature: in each movement, two tiny magnetic-fluid clutches rotate in geared opposition, with pen linked to output shafts and responding to resultant torques developed. High torque inherent in this unique design permits great reduction in size and weight; makes recorder meet military aircraft requirements for shock, vibration, explosion, and



humidity resistance. Non-corrosive pens are used for both recording and marker timing, with different color inks used on both pens for each channel. Paper is standard 6-in. curvilinear translucent chart available in 100-ft. rolls. Frequency response ranges through 15 cps. with 5-percent accuracy from d.c. through 6 cps. Sensitivity is 0.45 in. per 100 microamps. with linear recording range to 500 microamps. Undirectional recording is possible to 1 milliamp.—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

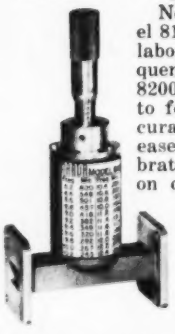
For more information circle **288** on inquiry card.

Pocket Volt-ammeters

Three new high-voltage models of "Amprobe Junior" have two a-c. voltage ranges: 0-150/600, and one a-c. amperes range: either 0-25, 0-50 or 0-100.—*Pyramid Instrument Corp., Lynbrook, N.Y.*

For more information circle **289** on inquiry card.

X-band Frequency Meter



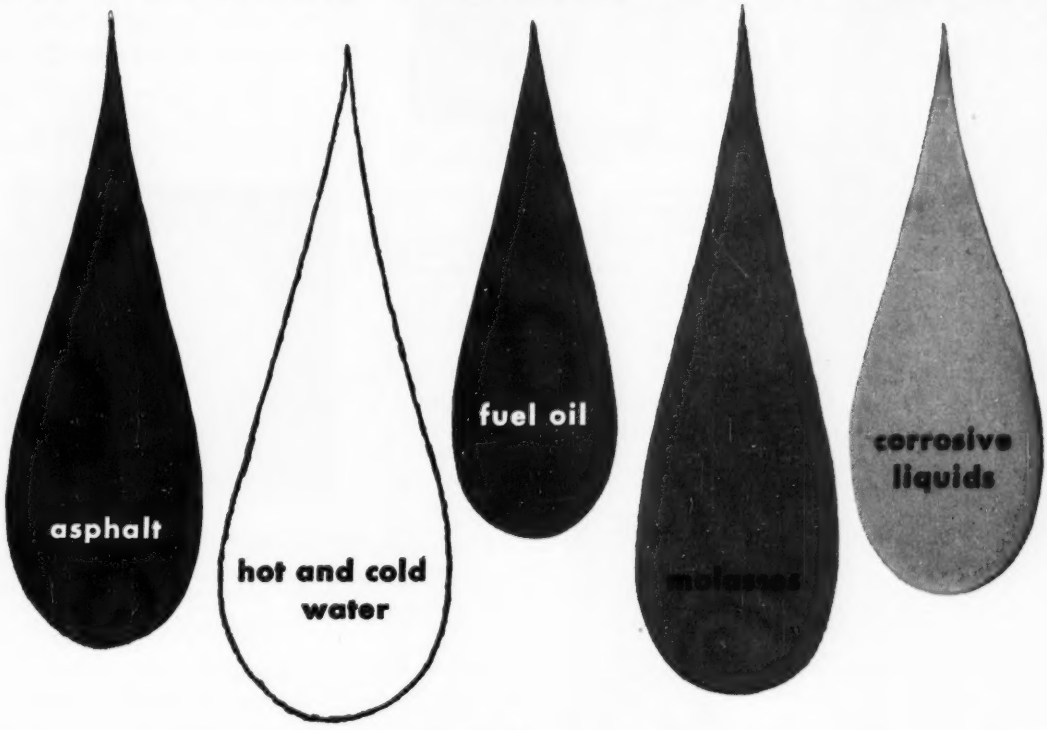
New "NARDA Model 810" is a microwave-laboratory type frequency meter for range 8200 to 12,400 Mc; said to feature high *Q;* accuracy 0.1 percent; ease of tuning; calibration chart mounted on cavity; large reactive dip for rapid location of resonance. It comprises a resonant cavity in TE111 mode, tunable by varying cavity length with a non-contacting shorting plunger. Cavity is mounted on a short length of 1x½ waveguide terminated in UG-39/U cover flanges.—*Nassau Research & Development Associates, Inc., 66 Main St., Mineola, N. Y.*

For more information circle **290** on inquiry card.

S-band Wavemeter

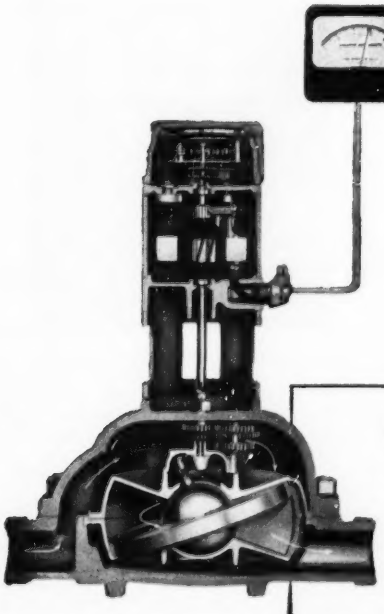
New "Model 229" S-band wavemeter, of coaxial-line type, covers frequency range from 2.3 to 4.5 kMc. Among its features: (1) precision-ground lead screw for accuracy of

viscosities unlimited



HAYS VERIFLOW METER AND HAYS ELECTRONIC VERITROL

indicate and control liquid flow



Now virtually all fluids can be precisely measured and accurately controlled—*from a remote position.*

Hays VERIFLOW meter accurately measures, indicates, and totals the flow of corrosive and hard-to-meter liquids without using weigh tanks, orifice plates, or gage sticks.

With the Hays VERITROL you simply set a knob at the rate of flow desired . . . then, the VERITROL controls the flow of liquid at that set-rate.

Send for a complete description of Hays Veriflow Meter and Veritrol, Pub. No. 53-766-38.

for corrosive liquids

Acetic Acid, Aluminum Potassium Sulphate, Ammonia, Calcium Compounds, Carbolic Acid, Formaldehyde, Fruit and Vegetable Juices, Hydrogen Peroxide, Phosphoric Acid, Potassium Hydroxide, Sodium Compounds, Sulphuric Acid (concentrated), Stearic Acid, and many others.

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For more information circle **67** on inquiry card.

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TEMPERATURE
TEST CHAMBER
FOR RAPID AMBIENT TEMPERATURE TESTS
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The Model TC-2 Temperature Test Chamber is a portable, self-contained, easy-to-operate unit ideal for laboratory and production line use.
Write for literature.
Temperature Range: —65°F to +350°F.
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Coolant: Dry ice, 15 lbs. capacity.
Dry Ice Loading Port.
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Test Load Access: Removable tray with 15 through ports.
Test Load Capacity: 600 cubic inches.
Power Requirements: 115 volts, 5 amperes, 50-60 cycles, single phase.
STATHAM DEVELOPMENT CORPORATION
12411 W. Olympic Blvd., Los Angeles 64, Calif.
Circle **68** on inquiry card.

NEW INSTRUMENTS

measurement; (2) cavity body, precision-machined from a solid block for mechanical stability; (3) use of Invar in line displacement portion for frequency stability throughout temperature range of 10 C. to 40 C.; (4) tri-plating of all RF surfaces.—*Amerac, Inc.*, 116 *Topsfield Road, Wenham, Mass.*

For more information circle **291** on inquiry card.

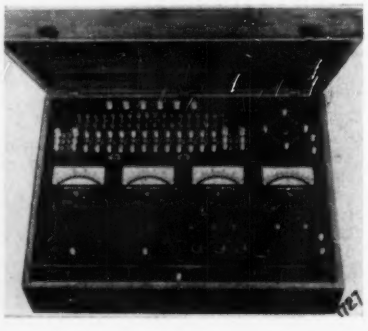
Portable D-c. Bridge

New "Normameter Model 185R" is a portable d-c. Wheatstone bridge said to "combine unusual precision, compactness, fast action, and low cost." It is suited to lab or to factory work such as selecting resistors to close tolerances. It measures resistances from 0.05 to 50,000 ohms in 5 ranges with built-in multipliers. Null-indicating galvanometer has a sensitivity of 4 microamps. per scale division. Accuracy is 0.5 percent to 5 percent, depending on range. Instrument operates on a replaceable 4.5-v. battery, from an external source of 4 volts, or (with adapter) from 115 v.ac. Weight 1½ lb.—*United Optical Mfg. Corp.*, 202-4 *East 19th Street, New York 3, N. Y.*

For more information circle **292** on inquiry card.

D-c. Measurements Set

New "Universal Measuring Test Set" for d.c. makes more than two hundred separate instrument ranges immediately available. It can be used as a Wheatstone bridge, potentiometer, zero-resistance microammeter or milliammeter, high-resistance voltmeter, r-f. voltmeter, r-f. milliammeter or ammeter; or used for d-c. power measurements, bridge-type a-c. rectifier, circuit tester, etc. Ranges of direct measurements extend from 1 microampere to 60 amperes and 1 millivolt to over 750 volts.—*Sensitive Research Instrument Corp., 9 Elm Ave., Mount Vernon, N. Y.*



For more information circle **293** on inquiry card.

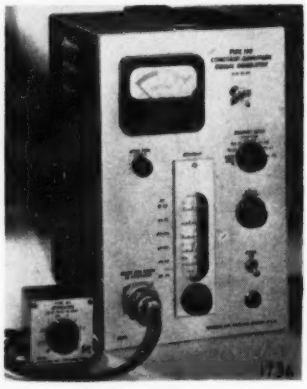
50-ampere Watthour Meter

New 50-amp. single-phase watthour meter of improved design and straight-line accuracy up to 200 amps. has a load range more than three times that of standard 15-amp. "I-50" with no increase in external dimensions.—*Meter & Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **294** on inquiry card.

Constant-Amplitude Signal Generator

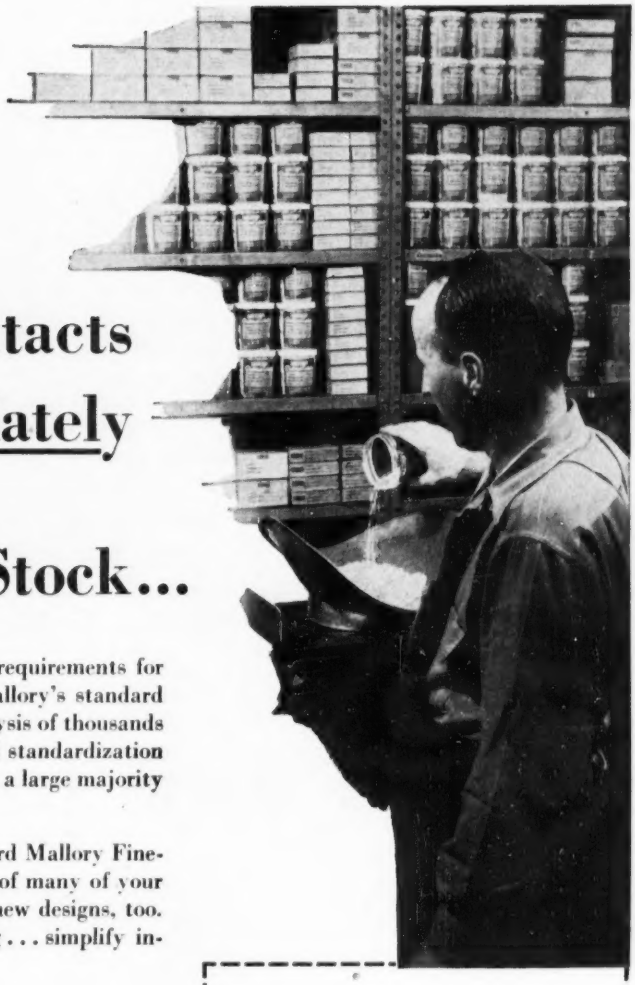
New "Type 190 Constant-Amplitude Signal Generator" generates sine waves in frequency range of 350 kc. to 50 Mc. continuously variable. Frequency indication accurate within 2 percent. Output amplitude continuously variable from 4 mv. to 10 v. peak-to-peak. Output impedance, 52 ohms.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*



For more information circle **295** on inquiry card.

Color-TV-signal Tester

New "Model VDE-2 Vector Display Equipment" is a field-test unit for checking distribution of a composite-color television signal. It provides a vector display of chrominance components of standard color bar signals,



Fine-Silver Contacts Shipped Immediately

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For the first time, you can order most of your requirements for fine-silver headed rivet contacts from stock! Mallory's standard stock program is the result of an engineering analysis of thousands of customer prints . . . an analysis that permitted standardization of 70 flat and radius-faced contacts that will meet a large majority of industry's requirements.

Check your present designs. You will find standard Mallory Fine-Silver Contacts that come within the tolerances of many of your requirements. Standardize the contacts in your new designs, too. It will save time in engineering and purchasing . . . simplify inventory problems.

The Mallory standard stock program offers:

- ***Prompt shipment, normally within 24 hours.***
- ***Immediate availability of samples when required.***
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For more information circle **69** on inquiry card.

The Duplex Function Plotter

—plots two variables vs a third

NEWEST of the many modifications of the *ElectroniK* recorder for research purposes is this two-pen version of the famous Function Plotter. It has three independent measuring systems; one for each of the horizontally moving pens, and one for the vertically moving chart. It is thus able to draw two simultaneous curves representing the relationship $x,x'=f(y)$.

The Duplex Function Plotter gives research men better data in the testing of missiles, engines, nuclear reactions and many other studies. It provides a continuous plot of two related functions on a single chart . . . eliminates the labor and possibility of human error in replotting from two separate records.

Input to either pen or to the y-axis can be practically any variable that can be converted to a d-c signal. All three inputs can be of different calibrations.

Two new instruments to

The *ElectraniK* Null Indicator

—the successor to the galvanometer

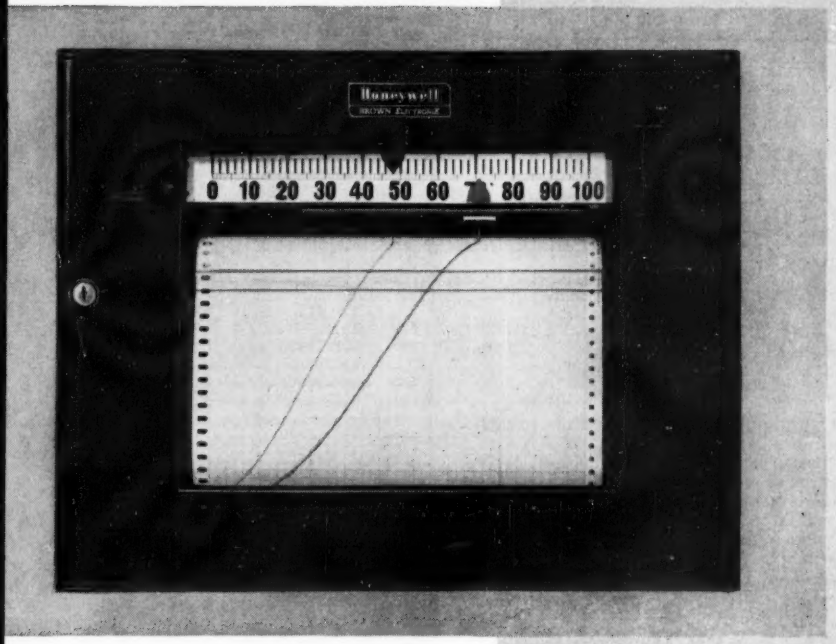
THE LAB MAN'S ideal null balance d-c detector, the *ElectroniK* Null Indicator is completely free from all the limitations of galvanometers. It speeds bridge-balancing operations, because there's no "loss of spot" from excess signal. It takes heavy overloads without damage. It's unaffected by vibration, and needs no special mounting or leveling.

The Null Indicator has high sensitivity and quick response. It indicates in less than one second . . . ideal for production testing. Its stable electronic circuit holds steady zero after warm-up. Just plug it into any 115-volt, 60 cycle line and it's ready to use.

Current sensitivity is 0.6×10^{-9} amperes per millimeter . . . voltage sensitivity 1 microvolt per millimeter. Input impedance is 1500 ohms. Economical price places the *ElectroniK* Null Indicator within the reach of any research budget.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

For more information circle 70 on inquiry card.



accelerate research

Your nearby Honeywell field engineer will be glad to discuss how these and other Honeywell instruments can help to save time and routine labor in your research work. Call him today . . . he's as near as your phone.

● **REFERENCE DATA:** Write for Data Sheet No. 10.0-7, "*ElectroniK* Duplex Function Plotter," and for Data Sheet No. 10.0-12, "*ElectroniK* Null Indicator."

For more information circle **70** on inquiry card.

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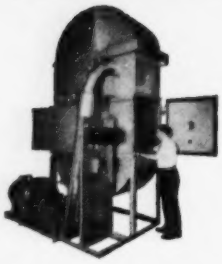
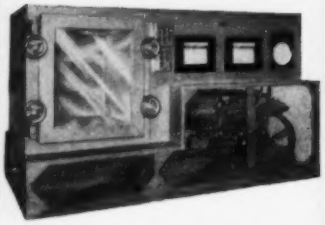
TEST EQUIPMENT



SAND & DUST test chambers with completely automatic dust density control.



ALTITUDE chambers for testing from sea level to 100,000 ft. or higher with temperatures from —100° F to +200° F.

HUMIDITY chamber simulates relative humidity from 20% to 100% between +35° F and +200° F.

American Research Test Equipment can be designed and built in a variety of sizes and ranges to meet specific requirements.

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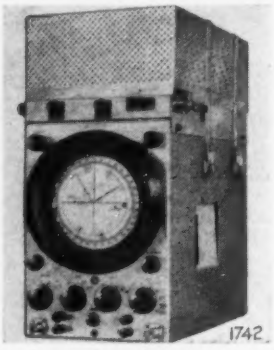
For more information circle **71** on inquiry card.

NEW INSTRUMENTS



or prominent chrominance components of any composite TV signal; also checks accuracy of color signal, drift in color coders and other generating equipment, and alignment of color coders using standard color bar signals.—*Wickes Engineering & Construction Co., 12th St. and Ferry Ave., Camden 4, N. J.*

For more information circle **296** on inquiry card.

VHF Receiver

New "Model SS50-200" is a professional quality VHF receiver for AM and FM in 50 to 200 Mc range, said to be the only receiver of its type covering these frequencies. Directly-calibrated 72-inch bandspread dial.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **297** on inquiry card.

VHF Receiver Converter

New "Model RC" 50-200 VHF receiver converter extends frequency range of a standard high-frequency receiver into VHF range of 50 to 200 Mc. Has self-contained power supply. No modification of receiver is required.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **298** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Short-wave Selector

New "Type MCL-500 Vari-Splitter" is said to provide "the exact realistic jam-free bandwidth for all long-range reception of short-wave single-sideband transmissions." It has been designed to "patch" into IF circuit of installed high-quality single-sideband receivers. Jamming attenuation is 60 db, 500-cps outside passband. Models available with provision to control passband of 1-, 2-, 3-, or 4-channel single-sideband signals.—*J. L. A. McLaughlin Corp., La Jolla, Calif.*

For more information circle **299** on inquiry card.

Electronic Chopper

New "Model 207 Electronic Chopper" utilizes a new principle involving modulation of d-c. voltages by alternate illumination, at line frequency, of photo-conductive element in a voltage divider. Among resulting advantages: no drift, with no applied voltage; no output can be produced by any resistance changes; noise less than 1 mv. referred to input. Weight 1.6 oz.; effective service at least 3000 hours. Recommended applications are in null measurement circuits, servomechanisms, computing devices, etc.—*Avion Instrument Corp., 299-50 State Highway No. 17, Paramus, N. J.*

For more information circle **300** on inquiry card.

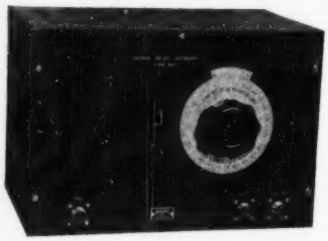
Decade Resistance Box

New Decade Resistance Box has a range of 0 to 11 megohms in 1,000-ohm steps, 4 decades; is said to combine quality workmanship with proper shielding; is accurate to 1 percent. Inherently stable deposited carbon resistors are used throughout. Immediate delivery.—*Stuart F. Louchheim Co., 1229 N. Broad St., Philadelphia 22, Pa.*

For more information circle **301** on inquiry card.

Adjustable-delay Network

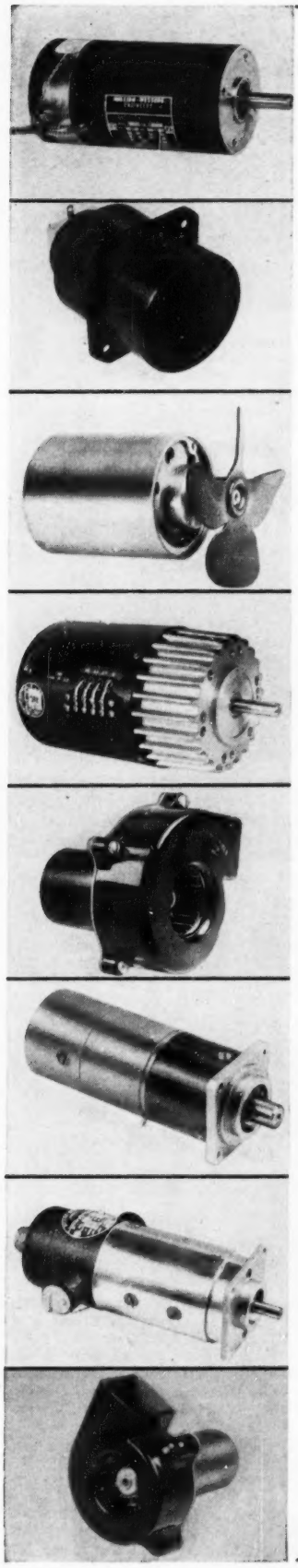
New "Type 2011 Continuously Variable Time Delay Passive Network" consists of a continuously-variable delay line, a step-variable delay line, an input cathode follower, a voltage amplifier, and two output cathode followers. Step-variable has a time delay of 10.5 usec. in steps of 0.5 usec.; continuously-variable has a total time delay of 0 to 0.5 usec. with resolution time less than 5×10^{-10} sec. Well suited for phase angle measurement, time measurement, etc.—*Advance Electronics Co., Inc., P. O. Box 394, Passaic, N. J.*



For more information circle **302** on inquiry card.

Square-wave Generator

New "Model HF-101" wide-range square-wave generator covers range of 5 cps. to 5 Mc. Frequencies lower than 5 cps. or higher than 5 Mc. can



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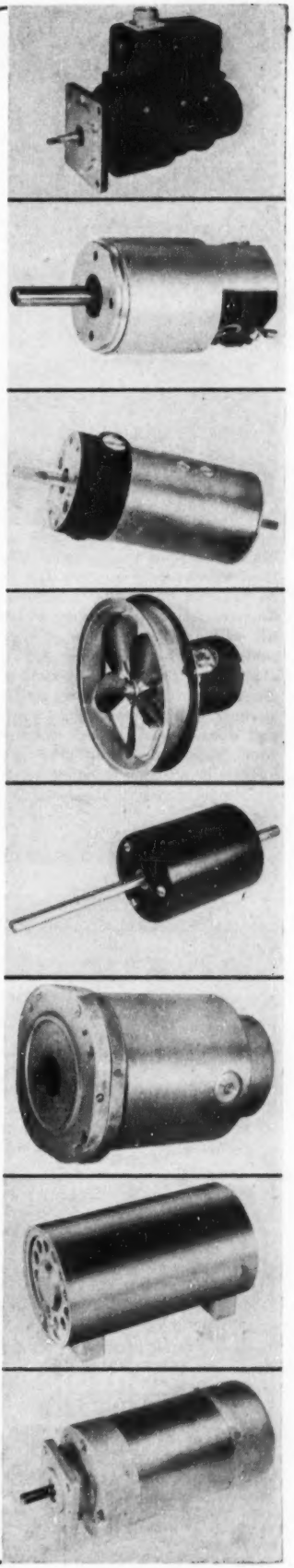

For more information circle **72** on inquiry card.

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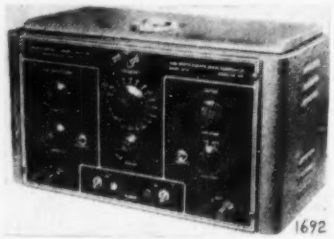
Circle **73** on inquiry card.

NEW INSTRUMENTS



1692

be obtained by use of an external capacitator. Waveform symmetry is adjustable. Output impedances of 75 and 500 ohms are provided. Rise time is approx. 0.02 usec. Power supply is regulated. Standby switch and indicator are incorporated.—*Linear Equipment Labs., Brightwater Place, Massapequa, L. I., N.Y.*

For more information circle **303** on inquiry card.

Wide-range Amplifier

New "Type 1206-B Unit Amplifier" for audio and ultrasonic frequencies has a maximum output of 3 watts;

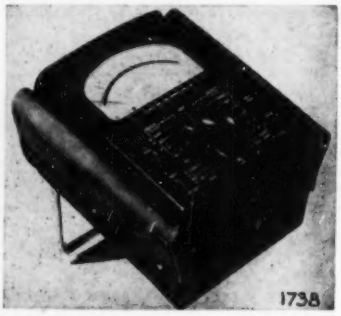
1560

requires less than 1 volt input for full output, hence can operate directly from output of sound-level and vibration meters, etc., for such purposes as operating recorders. Frequency range extends from below 10 cps. to about 250 kc. Harmonic distortion into a load of 600 ohms is less than 1 percent with 2 watts output (less than 2 percent with 3 watts) from 20 cps. to 40 kc.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **304** on inquiry card.

Neolite Case

New "No. 639-N" Neolite case is available to house three models of maker's volt-ohm-mil-ammeters, "Nos. 630, 630-A and 630-T." Built-in stand



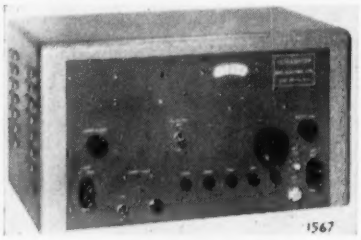
1738

rests unit at a convenient 45-deg. angle. Back compartment for instruction book, leads, stand and small tools. —*Triplett Electrical Instrument Co., Bluffton, Ohio.*

For more information circle **305** on inquiry card.

Sweep Generator

New "Ultra-Sweep," basically a high-output calibrated sweeping oscillator, is added to maker's new UHF



1567

TV series; is useful in development and production of UHF TV receivers and tuners.—*Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.*

For more information circle **306** on inquiry card.

Sweep Generator

New "Model Video TTV Marka-Sweep" fulfills all RETMA measurement requirements for video transmission equipment; is especially use-

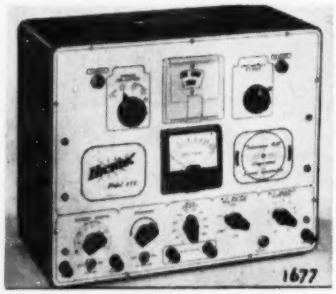
1528

ful in performing FCC proof of performance measurements on TV broadcast equipment. 50 kc. to 8 Mc. range. —*Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.*

For more information circle **307** on inquiry card.

TV Sweep Generator

New "Model 695" is a completely new electronic sweep generator to fill top requirements of professional TV servicemen or labs. No moving parts



1677

to produce vibration or wear out. Sweep signal is absolutely linear and without amplitude modulations. Triple shielding permits attenuation down into "snow region"; three RF oscillators.—*The Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.*

For more information circle **308** on inquiry card.

Microwave Bolometer

New "NARDA N-821B" bolometer for detection of microwave and UHF frequencies is of hot-wire type, re-

BORG *The New Standard for Precision Multiturn Potentiometers .... Eliminates The Necessity for Special Designs!*

New BORG MICROPOTS

Models Available for Test and Evaluation

Model No. 902BB

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BUSHING MOUNT AT BOTH ENDS

Designed for the utmost versatility and adaptability, Borg Micropots eliminate the need for special design. New standard Borg Micropots are available in single or double shaft models with exceptionally rigid servo-mount or bushing-mount at either or both ends. The housing floats on sturdy mounting flange.

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All potentiometers are available with double end support to assure efficient operation where subjected to excessive vibration. Precision ball bearings and precision rolled lead-screw provide higher accuracies and longer life. New scanning bar-contact reduces noise and lengthens life. Adjustable contact assembly provides higher accuracies at lower cost.

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THE GEORGE W. BORG CORPORATION

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For more information circle **74** on inquiry card.

NEW INSTRUMENTS

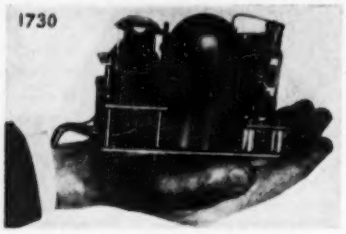
quiring a bias current of 8.75 ma. to obtain operating resistance of 200 ohms. Detection is square-law for power levels within any 40-db interval. Burn-out power is over 15 milliwatts; sensitivity is 4.5 ohms per milliwatt. —*Nassau Research & Development Associates, Inc., 66 Main St., Mineola, N. Y.*

For more information circle **309** on inquiry card.

POWER SUPPLIES

High-voltage Power Supply

New "Model PS 503" high-voltage power supply weighs 2 lbs., measures 4 x 2.6 x 5.5 in. Input of 275 v.dc. pro-

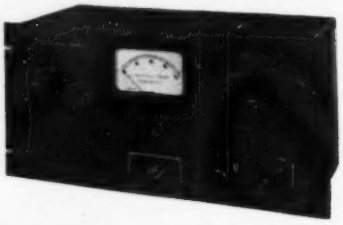


vides 5,000 v.dc. at 300 microamperes. Lower voltage at higher current can be obtained if desired. Transformer is hermetically sealed in epoxy resin and operates on 30 kc.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **310** on inquiry card.

Constant-current Source

New "Model CC-200" is an electronically-regulated a-c. operated ungrounded source of constant direct current continuously adjustable from 5 ma. to a maximum of 200 ma. Cur-

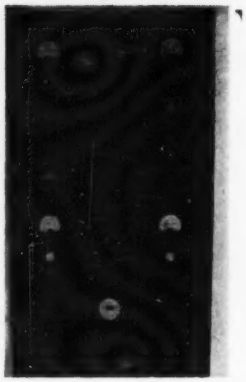


rent regulation is better than 0.5 percent for range 5-50 ma. and better than 1 percent for range 50-200 ma. for load variation of 0-250 volts. *Electronic Research Associates, Inc., 715 Main St., North Caldwell, N. J.*

For more information circle **311** on inquiry card.

Radar Pulse Modulator

New "Model 12 Laboratory Thyratron Pulse Modulator," for research in pulse power generation, is an electronically-switched power source designed to be externally triggered at various repetition rates (400 to 4000 pps.). Rated output power 250,000



peak watts into a 50-ohm load; duty cycle 0.01 percent; up to 20 volts to operate a magnetron. Indicating instruments are included to read operating voltage and current of modulator as well as current of magnetron oscillator if used.—*Dormitzer Electric & Manufacturing Co., Inc., 5 Hadley St., Cambridge, Mass.*

For more information circle **312** on inquiry card.

Power-supply Regulator

New "Kay-Lab Super-Regulator" converts ordinary power supplies to provide extremely low output impedance and ripple. Through use of extremely stable high-gain amplifiers and pentode series passing tubes, it is immune to variations of power supply proceeding it. Voltage range 200 to 350 volts; current range 0 to

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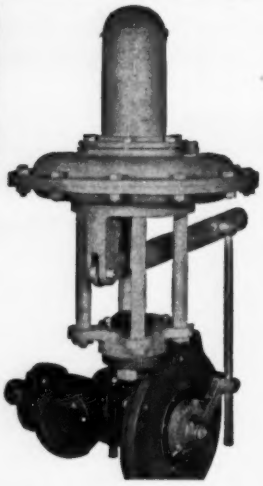

Available from stock. Assembled complete with any valve; North American, Hauck, Maxim-Premix, wafer-type butterfly, etc. All ovens, furnaces, kilns can be efficiently controlled by ConoMotor pneumatic diaphragm motors. Let us ship your burner valve assemblies complete with brackets, levers, etc. ready to mount and operate. Eliminate headaches . . . write for BULLETIN B1020 while you're thinking of it.

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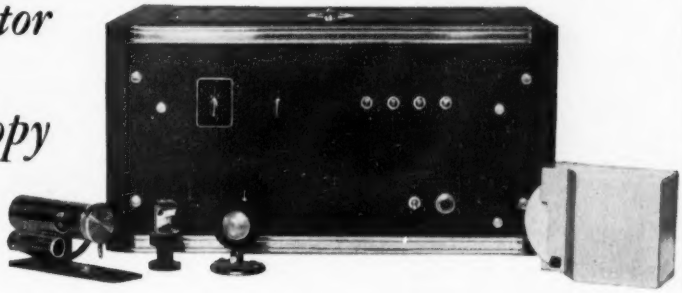
For more information circle **76** on inquiry card.

A Superior Detector

for

Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
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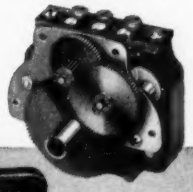

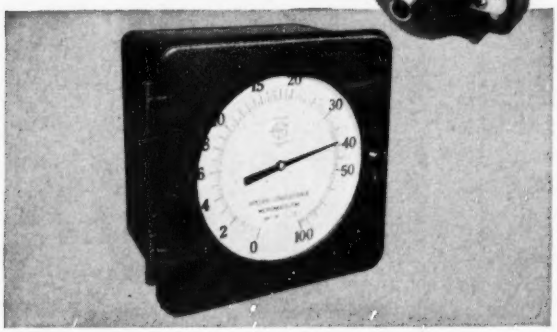

Product of Industrial Instruments, Inc., this compact, self-balancing, continuous indicator-controller is driven by a Barcol EYAZ reversible geared motor (above right). For precise actuation of your instruments, too, there's a wide line of high-torque, highly reliable Barcol Small Motors. Unidirectional, reversible, and synchronous . . . with or without gearing . . . open or enclosed . . . up to 1/30 hp.

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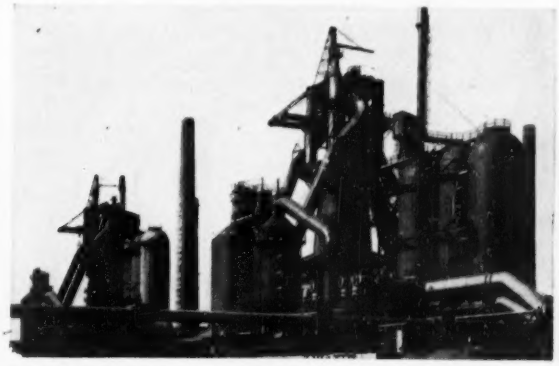

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The Cambridge Gas Analyzer gives continuous and simultaneous records of CO_2, H_2 and CO in blast furnace top gases. The instrument helps the operator to maintain a thermal balance and to identify the approach of a channelling or hanging furnace. The analyzer's alarm system assures early warning of water leaks or a cut tuyers.

The analyzer is accurate, sensitive and ruggedly built for steel mill use. The instrument is automatic in operation and requires only routine attention.

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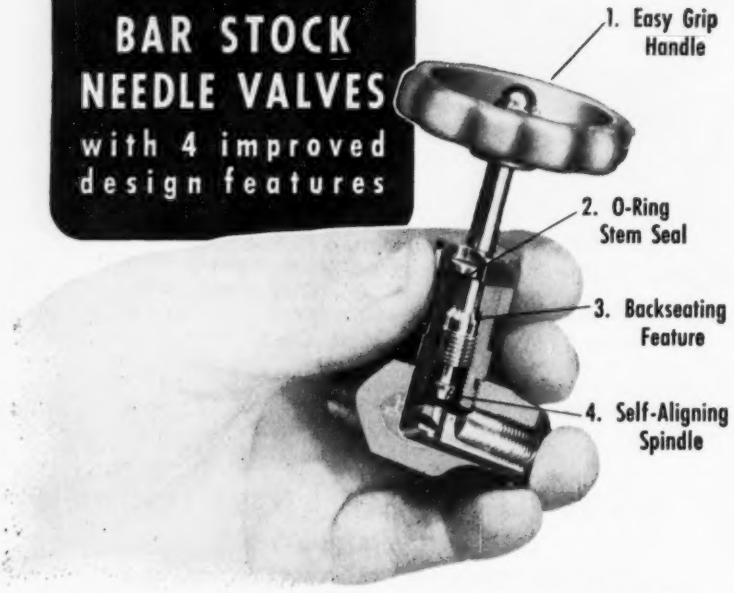
BAR STOCK NEEDLE VALVES

with 4 improved design features



The newest and most versatile bar stock needle valve now available—that's the HOKE 270 series for instrumentation, test panel and hydraulic service. The O-ring stem seal provides maximum tightness and eliminates packing adjustments. (Conventional packing is available, however, if desired.) An important new advantage is the backseating feature that permits O-ring or packing replacement under pressure, without shutting down. A self-aligning spindle has been designed to insure tight seating with minimum wear. The easy-grip handle is of die-cast anodized aluminum, with no sharp edges. An additional feature makes possible direct instrument panel mounting. These new bar stock valves are now available in sizes from ⅛" to ½" pipe — straight and angle patterns — manufactured from brass, Type 316 or 430F stainless steel. O-ring styles can be helium leak tested for use in non-critical high vacuum service.

Write for the New Hoke Catalog

This completely illustrated 68-page catalog contains specifications on needle valves of all sizes as well as toggle valves, special purpose valves, fittings and accessories. Tell us about your problem and we will gladly send you a copy of the catalog with our specific recommendations. Address your request to 231 S. Dean Street, Englewood, N. J.

HOKE

HOKE INCORPORATED

Fluid Control Specialists

ENGLEWOOD, NEW JERSEY

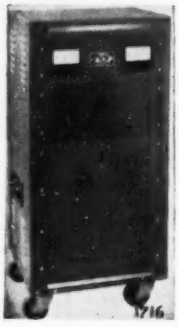
For more information circle **80** on inquiry card.

NEW INSTRUMENTS

450 ma.; load regulation for full load current change 0.01 percent; line regulation for 10 percent line voltage change 0.03 percent.—*Kalbfell Labs., 1090 Morena Blvd., San Diego 10, Calif.*

For more information circle **313** on inquiry card.

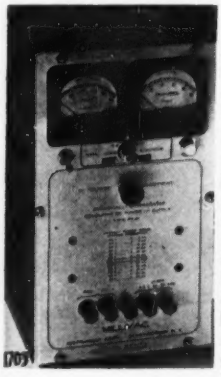
Mag.-amp.-reg. D-c. Supply



New "Model MR 1032-50" magnetic-amplifier-regulated power supply is rated at 10-32 volts d.c. at 50 amperes continuously. Magnetic amplifier regulation of 1 percent is from 0 to 50 amperes, over entire d-c. voltage range of 10 to 32, and for a-c. input voltage range of 220 plus or minus 10 percent. Ripple is 1 percent rms. maximum and recovery time is 0.1 second.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **314** on inquiry card.

D-c. Power Supplies

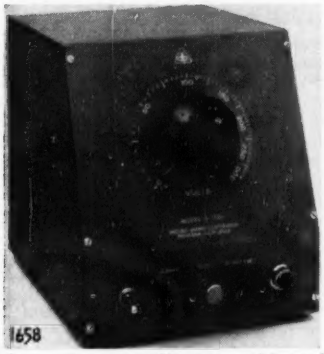


New "RP" d-c. power supplies, said to "have high stability at a reasonable cost," are dynamically compensated to provide zero or slightly negative internal impedance to compensate for voltage drops in lines between power supply and consumer. Voltage from 250 to 400; current from 50 to 100 ma.—*Millivac Instrument Corp., P.O. Box 997, Schenectady, N. Y.*

For more information circle **315** on inquiry card.

D-c. Power Supplies

New low-priced d-c. power supplies, designed for laboratory and experimental applications, come in two types: "Model 3-150-L," a cabinet-mounted unit with an output voltage range up to 300, and a series of sub-chassis-mounting-type packages with d-c. voltages ranging from 150 to 500.



Prices of new units are said to be lower than customer's cost of components.—*Dresden-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **316** on inquiry card.

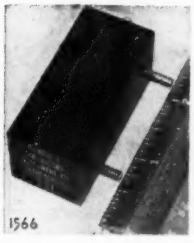
ELECTRICAL and ELECTRONIC COMPONENTS

Varistor Experimental Kits

Two new "Thyrite" varistor kits provide a variety of miniature disk-type and rod-type varistors for experimental applications in electronics, communications, power control, and allied industries. "No. 108L338G1," miniature disk-type—12 varistors, two each of six ratings, color-coded with connecting leads; "No. 108L338G2," rod-type—10 varistors, two each of five ratings, color-coded with connecting leads. Both kits contain tables of physical and electrical properties and log-log volt-ampere characteristics graphs.—*Dept. 42-211, General Electric Co., Pittsfield, Mass.*

For more information circle **317** on inquiry card.

Military-type Delay Lines

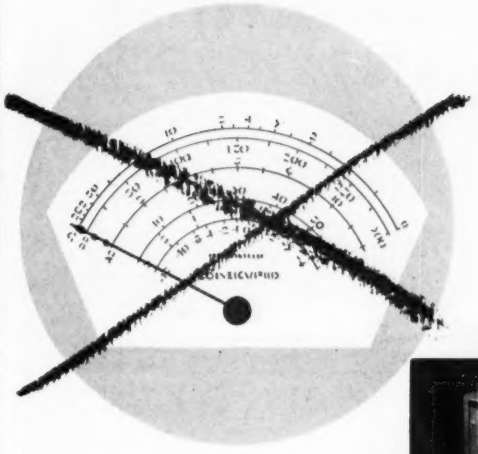


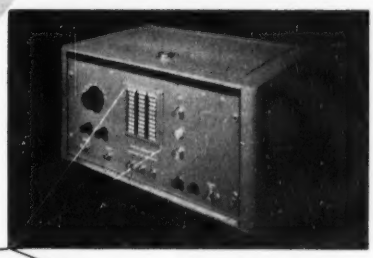
New precision delay lines for military uses are said to be characterized by excellent electrical characteristics, constancy of delay with temperature stability, hermetic sealing, and resistance to shock and vibration.—*Jacobs Instrument Co., Bethesda 14, Md.*

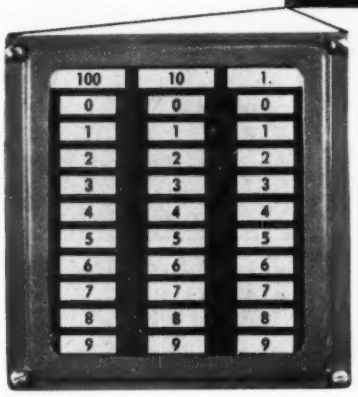
For more information circle **318** on inquiry card.

Miniature Inductors

New "SL2" series comprises 13 miniature inductors for use as inductor elements in turned circuits and filter networks and as chokes in







The Digitester $1185.00

Telecomputing's new digital instrument

measures resistance, voltage and current with push-button speed

The versatile Digitester serves as a combination digital volt-ohm-milliampere meter, gives you 0.1% accuracy and .8 second speed. In addition, readout is in decimal numbers instead of analog form.

Wide measuring ranges are an important advantage of the Digitester. You can measure up to 10 megohms, 1000 volts, or 1 ampere. Maximum accuracies (lowest scales) are ±.01 ohms; ±.00001 volts; ± .01 microamperes.

Operation does not involve any manual adjusting or balancing. You simply press a panel button to get decimal readout.

A digital ohm meter called the Digitohm is also available at $985.00. It measures resistance with the same speed, accuracy and wide range as the Digitester.

Specifications on the Digitester and Digitohm will be sent you upon request. Please address inquiries to Preston W. Simms, Dept. I-4

TELECOMPUTING CORPORATION

BURBANK, CALIFORNIA • Washington, D. C.

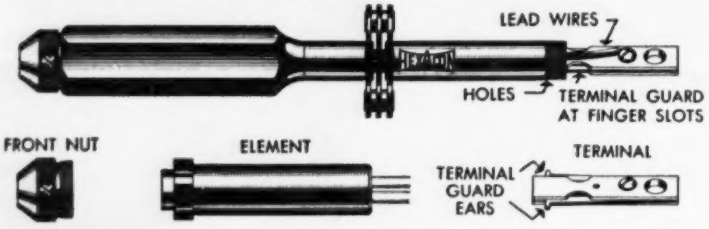
For more information circle **81** on inquiry card.

NOW! CHANGE SOLDERING IRON ELEMENTS IN A JIFFY!

with HEXACON

*Patent Applied For

Readily Removable Terminal* does the trick!



ALSO NEW! BRASS-SHEATHED ELEMENTS
Easier to replace — Better Protection

Quick-change terminal can be removed in a second or two, permitting replacement of element in a fraction of the usual time. By simply depressing terminal guard at the finger slots, the terminal comes out in a jiffy — no longer necessary to fish element lead wires around terminal.

HEXACON — Industry's No. 1 Soldering Iron

Write for catalog showing 40 industrial soldering irons of every type and size; there is no obligation.

HEXACON ELECTRIC COMPANY
179 W. CLAY AVE., ROSELLE PARK, NEW JERSEY

For more information circle **82** on inquiry card.

SYNCHRON® TIMING MOTOR

"Work Horse of the Industry"

SINCE 1926

Every SYNCHRON Timing Motor must undergo 51 inspections and a grueling final test before shipment! Long-lasting accuracy and dependability are built in!

Invitation to Designers

If your product requires trouble-free synchronous timing motors or timing machines, get complete, concise engineering data showing how easily SYNCHRON Motors may be applied to mechanisms now in production or in the idea stage.

Consult HANSEN engineers without obligation.

SYNCHRON Timing Motors start instantly, pull up to 8 in. oz. at 1 RPM, operate in any position at temperatures from -40° to +140° F. Available with gear trains to convert any speed.

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Send catalog and engineering data to:

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Address .....
City ..... Zone ..... State .....

For more information circle **83** on inquiry card.

NEW INSTRUMENTS

telemetering and navigational systems. Units are individually adjusted before impregnation. Available values: 2.2 to 220 mh. Curie temperature 342 F. Weight 0.5 oz.—*Mico Instrument Co., 86 Trowbridge St., Cambridge 38, Mass.*

For more information circle **319** on inquiry card.

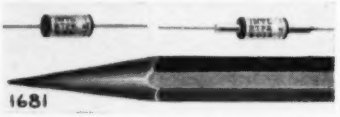
High-Q Core Material

New "Ferramic Q" is said to be "an ideal core material for antenna rods, filter inductances, leading coils, rf coils and all other applications requiring high performance at any frequency up to 30 Mc." and to be "completely stable in respect to age, shock, vibration and temperature."—*General Ceramics & Steatite Corp., Keasbey, N. J.*

For more information circle **320** on inquiry card.

Germanium Mixer Diodes

New UHF germanium mixer diodes are available in production quantities but each unit is manufactured from specially-treated single-crystal ger-



manium to assure maximum uniformity of characteristics. Frequencies up to 3,000 Mc.; exceptionally low noise figure of 10-14 db at 500 Mc. Withstand severe shock and vibration as well as extreme atmospheric conditions.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **321** on inquiry card.

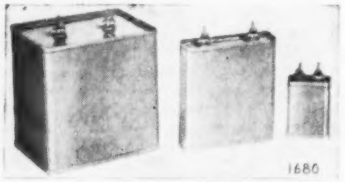
High-temperature Capacitors

New "Hy-Met" high-temperature units (to 125 C.) are added to "Metalite" line of metallized paper capacitors, use a newly-developed solid thermosetting impregnant said to eliminate all possibilities of impregnant leakage; are available in metal and paper tubular, as well as bathtub containers; including MIL-C-25A case styles and sizes.—*Astron Corp., 255 Grant Ave., East Newark, N. J.*

For more information circle **322** on inquiry card.

4800-hr.-*t* Capacitors

New "Stabelex D" capacitors, hermetically sealed, with a time constant in excess of 4800 hours, are offered in a full selection of values, as well



as case sizes, for upright or inverted mounting, including types for mounting where space is extremely limited. Change in capacitance from room temperature to 75 C. is -0.4 percent. —*Dep't I-21, Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill.*

For more information circle **323** on inquiry card.

Bifilar IF Transformers

New small bifilar type IF transformers are wound on ceramic forms and vacuum-impregnated with Silicone varnish for moisture resistance. Units are adjustable in that they are slug-tuned. Small fixed-tuned and slug-tuned solenoids and peaking coils are also available.—*Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.*

For more information circle **324** on inquiry card.

Subminiature Trimmer VDRs

New "RV⅛ Subminiature Trimmer Potentiometers" are designed for computers, analyzers, telemetering and control systems, etc., where trimming or calibration adjustments must be

capable of precise setting and re-setting and where stability of values under extreme temperatures, vibration, shock or corrosive environment is required. Available resistance values, 50 to 15,000 ohms.—*Technology Instrument Co., Acton, Mass.*

For more information circle **325** on inquiry card.

Deposited-carbon Resistors

New line of hermetically-sealed deposited-carbon resistors with ratings from 0.25 watt to 2 watts is said to be complete. Units are not varnish-coated but completely sealed in steatite housings.—*Mepco, Inc., Morristown, N. J.*

For more information circle **326** on inquiry card.

Axial-lead Resistors

New axial lead resistors are wound on fibre-glass cord in a continuous length. Cord is cut to required length; leads are clamped to each end; core is coated with silicone cement and inserted in a ceramic tube which affords mechanical protection and high dielectric strength. Ends are then sealed with silicone cement. Units are supplied in standard ratings of 5, 7 and 10 watts and to maximum resistance values of 1000, 5000, and 7500 ohms.—*Tru-Ohm Products, Div. Model Eng. & Mfg. Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill.*

For more information circle **327** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Subminiature Terminal Block

New subminiature barrier-type terminal block (max. length 4⅝ in.) is the smallest standard style terminal

block made; is said to have "all the good mechanical and electrical characteristics of much larger units. Molded of CFG, MFE, MME, and

precision electronic instruments by DeJUR
DC MILLIAMPERES
Model R-210
The DeJUR 2½"
RUGGEDIZED
Round Panel Meter
★ Exceptional resistance to shock and vibration.
★ Internal shock mounts are symmetrical for uniform lateral and horizontal excursion.
★ Unique external shock mount at flange cushions scale window, supplements internal shock-proofing.
★ Special shock mount rubber provides high dielectric strength, good low temperature characteristics, resistance to corrosion due to heat.
★ Hermetically sealed window and terminals are soldered to a one-piece drawn steel housing for positive immersion and weather resistance.
★ Qualified under spec. MIL M-10304 SIG. C.
★ Prototype to production on short notice.
For further information write DeJUR-Amsco Corporation, Dept. IR-4, 45-01 Northern Boulevard, Long Island City 1, New York.
ELECTRONIC DeJUR U.S.A. INSTRUMENTS
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POTENTIOMETERS • CONNECTORS • METERS
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For more information circle **84** on inquiry card.

YOU NAME THE LIQUID . . .

BOWSER

WILL MEASURE IT WITH XACTO

. . . "the meter that changed chemical processing habits"!

For over a quarter century Bowser Xacto meters have brought to the chemical industry an entirely new way to measure liquids accurately and dependably.

Wherever accurate measurement is essential to assure uniformity of product and control costs . . . there you will usually find Bowser Xacto meters on the job.

Today XACTO meters are handling these and 638 other liquids. . . .

Acetic Anhydride	Amyl Acetate	Carbolic Acid	Iso-Propyl Acetate
Alum Solution	Anhydrous Ammonia	Cellosolve Acetate	Lactic Acid
Ammonium Chloride	Aqueous Ammonia	Copper Nitrate	Napthenic Acid
Ammonium Nitrate	Arsenic Acid	Copper Sulphate	Resin Alkyd
Ammonium Phosphate	Butyl Acetate	Cresol	Stearic Acid
Ammonium Sulphate	Calcium Bisulphite	Cresylic Acid	Tannic Acid

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BOWSER, INC., 1367 Creighton Avenue, Fort Wayne 2, Ind.

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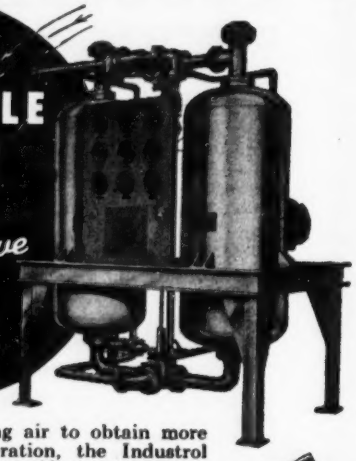
For more information circle **85** on inquiry card.

for DEPENDABLE Instrument Operation You Must Have CLEAN-DRY AIR



When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

Industrol CORPORATION

Subsidiary of Trinity Equipment Corporation

2368

For more information circle **86** on inquiry card.

NEW INSTRUMENTS

MDG in accordance with MIL-P-14C; supplied in 1 to 21 terminals. Three styles: (1) screw type as shown (Mfr's #409) designed to take AMP ⅛-in. wide solderless spade lug; (2) with a "one-sided" soldering lug attached (#409-¾ ST); with a "two-sided" soldering lug attached (#409-ST).—*Kulka Electric Mfg. Co., Inc., Mt. Vernon, N. Y.*

For more information circle **328** on inquiry card.

Aircraft Switches

New environment-proof switches for use in exposed locations in aircraft may be mounted near fuel tanks without danger of igniting escaping gases or liquids. Drain holes allow drainage of any moisture that might collect within housing. Typical of new series is "IEHI-Y," shown, with operating force of 9 lbs. and total plunger travel of ⅜ in.—*Micro Switch, Freeport, Illinois.*

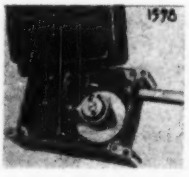
For more information circle **329** on inquiry card.

Mercury Switch

New hermetically-sealed s-p.d-t. magnetically-operated mercury switch requires exceptionally low loading of actuating system; provides for optimum accuracy when used as a position indicating and limit switch: in automatic scales, revolution counters and recorders, and laboratory equipment where little actuating power is available. Standard from 12 v. 0.25 amp. to 120 v. 1 amp.; prompt delivery.—*Dept. I-24, Hamlin, Inc., 1316 Sherman Ave., Evanston, Ill.*

For more information circle **330** on inquiry card.

Rotary Limit Switch

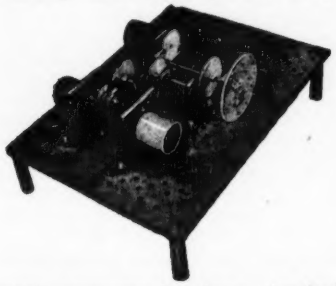


New rotary limit switch with cam and gear mechanism, for use where movement can be expressed as shaft revolutions, works as an automatic controller. Large selection of gear ratios; easily-adjusted positive-locking cams; enclosure of molded "Gemco Fibraloy." (NEMA Type 4 and 7 enclosures also available.) Two cam-operated switches supply one open and one closed circuit for each travel position.—*Gemco Electric, 25685 W. 8 Mi. Rd., Detroit 19, Mich.*

For more information circle **331** on inquiry card.

ServomechanismComponents

New components are announced whereby users can assemble bread-



board servomechanisms (maker's "Servoboard" or others) for experimental or actual testing purposes.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.*

For more information circle **332** on inquiry card.

Crossbar Switch

New "Crossbar Switch," for automatic control systems and computers, features modular construction; pro-

vides a fast, economical means of interconnecting or selecting many different circuits common to large-scale complex switching. It is mounted for drawer-like removal from its rack; provides any circuit connection in about 50 milliseconds; is capable of connecting any 3 of 60 circuits to any 75, or choosing one circuit from as many as 936.—*Industrial Dep't, Kellogg Switchboard and Supply Co., 79 W. Monroe St., Chicago, Ill.*

For more information circle **333** on inquiry card.

Relay Dust Cover

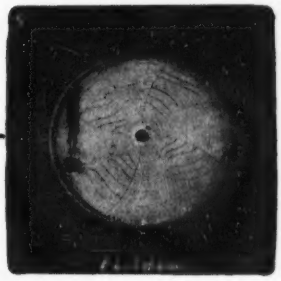
New low-cost dust cover for "Model DOS Relay" is of deep-drawn one-piece aluminum; fits snugly over aluminum plate on which relay and its plug-in base are mounted. It can be removed for inspecting relay.—*American Relay & Controls, Inc., 3645 Howard St., Skokie, Illinois.*

For more information circle **334** on inquiry card.

Miniature PM Generator

New "Type 44A" generator is recommended for instrument indicating and other similar applications. Volt-

The Fielden Instrument Division (Robertshaw-Fulton Controls Co.) recently introduced their newest 24-point recorder choosing Edison Resistance Temperature Detectors to complement the accuracy of their instrument.



For Temperature Recording...

EDISON

Resistance Temperature Detectors

Increase efficiency. Save steps. Save maintenance.

With Edison Resistance Temperature Detectors you can disconnect and reconnect the element from the indicator, recorder or controller without the annoyance of calibrating the instrument for lead resistance changes.

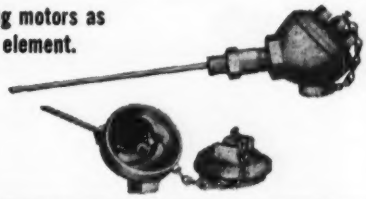
Edison Resistance Temperature Detectors reduce maintenance troubles caused by poor connections. Resistance Detectors are not affected by induced currents caused by stray voltage leaks in applications involving protection of large electric motors and motor-driven machinery.

Model 175: For industrial applications in compressor lines, oil lines, etc.

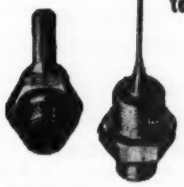
Basic Resistance: 45.5 ohms at 0°C.
Temperature Range: −70° to +300°C.
Stem lengths: 15/16", 1⅞", 4" or 8"
Mounting thread: ⅝-18
Mating connector: AN3106-12S-3S

Model 166NC: For service on sleeve bearing motors as an overtemperature sensing element.

Basic Resistance: 120 ohms at 0°C.
Temperature Range: −70° to +300°C.
Detector length: to 4 feet
Maximum diameter: .218"
With cap removed, detector can be withdrawn and replaced without further disassembly of the holder or conduit.



Model 221:



For fast response in connection with systems for automatic temperature detection, control, recording and indication.

Stainless steel stem has been flattened to increase thermal conductivity between stem and the hermetically sealed inner element. The result is an increase in thermal coupling to the resistance winding which reduces the exponential time-constant to 0.8 second or better in an agitated water bath.

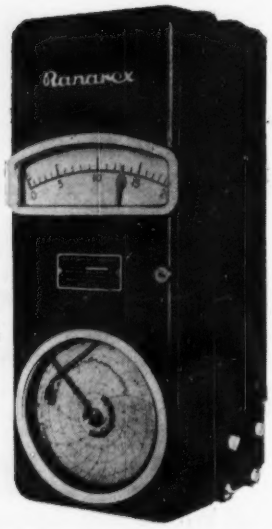
Basic Resistance: 90.38 ohms at 0°C.
Temperature Range: −70° to +200° C. with an accuracy of ±1%
Mounting thread: ⅜-14 NF
Mating connector: AN3106-12S-3S

For further information or for obligation-free consultation with Edison engineers on the adaptation of Edison Resistance Temperature Detectors to your equipment, write:

Thomas A Edison
INCORPORATED
Instrument Division
24 Lakeside Avenue, West Orange, New Jersey

For more information circle **87** on inquiry card.

FOR
FAST GAS ANALYSIS



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• Combustion Gases • Chemical Process Gases • Petroleum & Refining Gases • Inert Atmospheres • Gas & Gas/Air Mixtures • Heat-treating Atmospheres • Gas Specific Gravity

ADVANTAGES!
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. . . Short Lag
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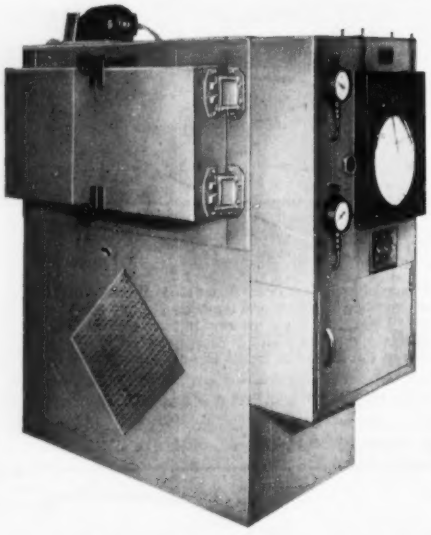
For more information circle **88** on inquiry card.

TEST CHAMBERS



HIGH & LOW TEMPERATURES CONTROLLED HUMIDITY

- **+200°F. to —150°F.**
- **20% to 95% R.H.**
- **1 cu. ft. to 75 cu. ft. cabinets**

Walk-in Rooms
Temperature Baths

Electronic or pneumatic recording or indicating control systems

CUSTOM CHAMBERS built to specifications.

Standard CABINET COMPANY

Years of satisfactory service!
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For more information circle **89** on inquiry card.

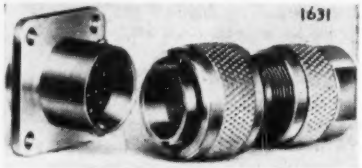
NEW INSTRUMENTS

age is linear with speed; 33 volts of 2-phase a-c. at 4500 rpm. Internal winding resistance is 30,000 ohms per phase. Weight 8 oz. Length 2⅛ in.; 5/32-in. shaft extends 0.34 in. Special shaft arrangements including splines, keyways, and gears can be supplied. Unit is pressure-sealed; has permanently-lubricated bearings; electrical leads or terminations supplied in different types as required.—*Dalmotor Co., 1342 Clay St., Santa Clara, Calif.*

For more information circle **335** on inquiry card.

Bayonet-locking Connectors

New "Series B" bayonet-locking miniature connectors for external applications are completely weatherproof when connected; suitable for

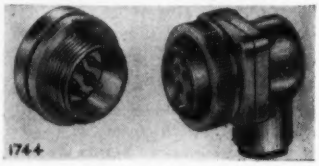


airborne equipment, etc. Die-cast aluminum shells; synthetic rubber seal rings; contacts gold plated over silver. Connectors available with 12, 14, or 24 contacts.—*Dep't R, Winchester Electronics, Inc., Glenbrook, Conn.*

For more information circle **336** on inquiry card.

Miniature Connector

New "CRA5-2" is a miniature pressure-tight electronic connector in a die-cast aluminum shell, for use in

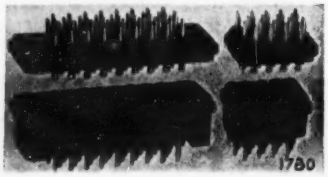


applications requiring pressurization. Sealing is accomplished throughout connector and around each contact by individual "O" rings. Air leakage less than 1 cu. in. per hour at 30 psi.—*Dep't R, Winchester Electronics, Inc., Glenbrook, Conn.*

For more information circle **337** on inquiry card.

Easy-release Connectors

New "Series MEZ-16 Easy Release" power connector, for use where minimum insertion and disengagement

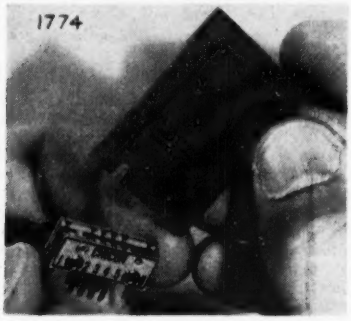


forces are desired, has spring-loaded cartridge-type contacts preventing damage to contacts and molded body; enclosed spring; pin contact with a free-floating action. Available in 18 and 34 contacts, made in accordance with BUORD drawings.—*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **338** on inquiry card.

Printed-circuit Connectors

New "Circon" miniature and subminiature printed circuit connectors are of a new design which, it is said,

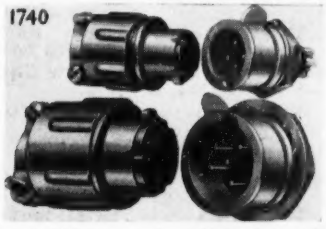


"promises as revolutionary an advancement in the electrical connector field as the transistor offers in replacing the vacuum tube." Sixteen models in each of miniature and subminiature series (total 32) in basic modules of 2, 4, 6 and 12 contacts at rated maximum loads of 1 and 2 amps. per contact permit side-by-side and end-to-end mounting combinations.—*Circon Component Co.*, 17544 *Raymer St., Northbridge, Calif.*

For more information circle **339** on inquiry card.

Miniature Connectors

Two new series of miniature circular connectors feature positive polarization by means of keyway in receptacle and key on plug. Both mating



and locking can be effected by feel alone: no need to check visually. Aluminum shell has Iridite finish, serves as a shield. One series comes with 1 to 4 contacts; the other comes with 5 to 9 contacts.—*Viking Electric*, 1061 *Ingraham St., Los Angeles* 17, *Calif.*

For more information circle **340** on inquiry card.

Miniature AN Connectors

New "165 Series" of miniature AN connectors featuring reduced weight are available in two sizes, six configurations, with 5, 9, 11, 12, 14 or 24 gold-plated contacts. They are pressurized but not hermetically sealed and will far exceed government-required fifty-hour salt-spray test.—*American Phenolic Corp., Chicago* 50, *Ill.*

For more information circle **341** on inquiry card.

Hoods with Cable Clamps

New aluminum hoods for "Series M" miniature electrical connectors offer protection, support and strain

TWO Chace Thermostatic Bimetal elements are used in The Republic "Gyroscopic-Balance" system for controlling room temperatures to within 1/10 degree. Instead of full on and off heat supply at delayed intervals this unit "meters" out the heat to balance perfectly the heat losses as steadily as a spinning gyroscope stands on a seal's nose.

Coupled with a three-wire thermostat, the Republic unit provides not only on and off control but also high and low flame in steps to balance heating losses accurately. The system does not need the necessary delay interval built into two-wire thermostats to prevent cycling.

Republic's system permits a floating contact in the thermostat which is sensitive to 1/10 degree and immediate action. Contact at the thermostat causes resistor (1) to heat, with a resultant bending of bimetal element (2) and, after a moment, the closing of contacts (3). This circuit opens the fuel valve to low flame. The contacts influenced by a magnetic field cannot open, thus preventing cycling.

The second set of contacts in the thermostat, sensitive to 1 to 1½ degrees, causes resistor (4) to heat, bending bimetal (5). This action closes a small gas valve permitting the burner to go to high flame. Thus the rate of fuel burned changes constantly to match the varying heat recording in the room.

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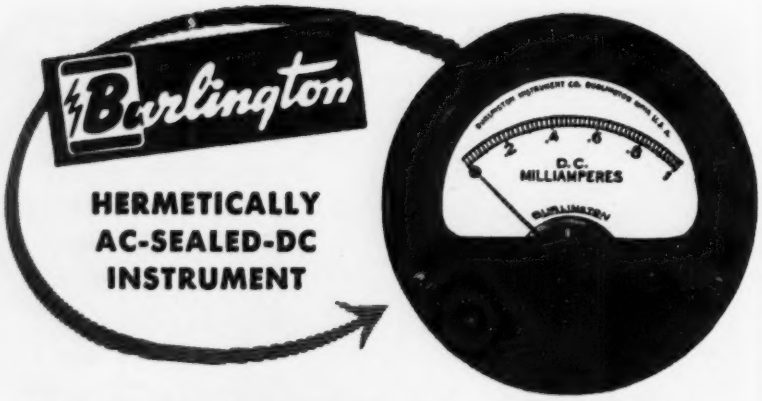
For more information circle **90** on inquiry card.



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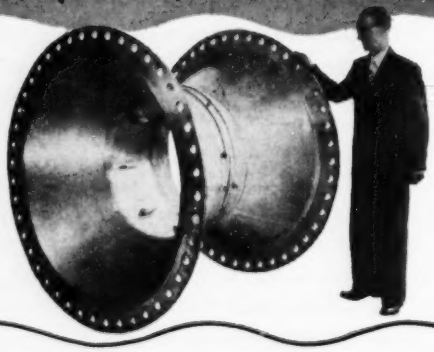

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For more information circle **92** on inquiry card.

NEW INSTRUMENTS

relief for cable. Cadmium plating with clear Iridite finish for corrosion resistance.—*Dep't R, Winchester Electronics, Inc., Glenbrook, Conn.*

For more information circle **342** on inquiry card.

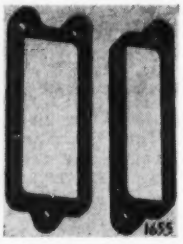
Coaxial Test Plug

New "Part No. RCP-18-120" is a type N male coaxial test plug, for testing in inaccessible coaxial circuits, may also be designed and incorporated into communications and radar equipment to permit constant or intermittent monitoring of a signal source from a control panel. Body is of brass, silver-plated; contact fingers are phosphor bronze; insulating material is GE 1422.—*Coaxial Connector Co., 37 North Second Ave., Mount Vernon, N.Y.*

For more information circle **343** on inquiry card.

MECHANICAL COMPONENTS

Connector Brackets



New mounting brackets for "EZ-16 Easy Release" connectors insure free-floating action which is necessary to take advantage of connector's self-aligning feature.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N.Y.*

For more information circle **344** on inquiry card.

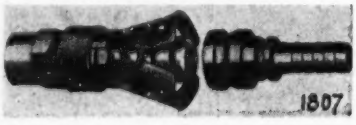
Vibration Mount

New "Model K 130" all-metal mount isolates individual instruments from vibration and shock. Instruments which cannot be located on main instrument panel can be installed anywhere in aircraft. Illustration shows how Douglas Aircraft employs "K 130" to protect an oxygen flow regulator. Modifications to fit standard various instrument housings are available.—*Robinson Aviation, Inc., Teterboro, N. J.*

For more information circle **345** on inquiry card.

Valve Coupling

New "Quick-As-Wink" valve coupling for air lines assures a tight swivel seal, locked safety connection, and quick easy disconnection. Joint is tightly sealed by internal fluid pres-

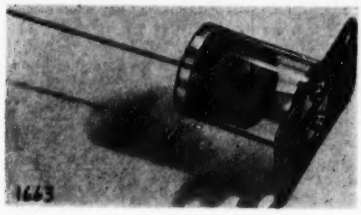


sure acting on "O" ring, but two halves are able to swivel freely without leakage, to prevent hoses from kinking, etc. A 90-degree twist of brass sleeve, when it is in "Off and Exhaust" position, locks it in this position, and permits hose to be moved around without danger of accidentally opening valve and exhausting live air. —*C. B. Hunt & Son, Inc., Salem, Ohio.*

For more information circle **346** on inquiry card.

Air-damp Dashpot

New air-damp dashpot, for use as a system stabilizer in control mechanisms and switchgear, weighs less than 0.5 oz.; has been used on maker's own voltage regulators; eliminates round-

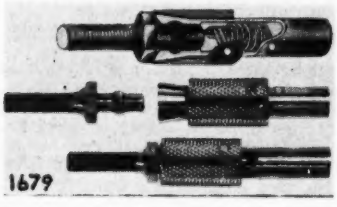


about solutions for mechanical damping and shock absorption; operates in any position at temperatures from – 75 C. to 150 C. Damping constant is adjustable up to 0.06 lb.-sec./in.—*Electric Regulator Corp., Norwalk, Conn.*

For more information circle **347** on inquiry card.

Quick-disconnect Unit

New quick disconnect unit for rod or cable controls is specifically designed to eliminate endplay and looseness; features a chuck-like locking unit with sliding collet; has withstood



vibration tests far beyond maximum life-expectancy standards; can be connected and disconnected quickly with one hand, even when located out of worker's sight, without loosening turnbuckles. Supplied from stock for all standard thread sizes.—*Hydraulic Products Co., 80 Federal St., Boston, Mass.*

For more information circle **348** on inquiry card.

Heavy-wall Saran Tubing

New heavy-wall tubing comparable to standard Saran tubing is 2⅝-in. O.D. x 1½-in. I.D.; can be furnished in 3-ft. lengths.—*Pyramid Plastics, Inc., 554 W. Polk St., Chicago 7, Ill.*

For more information circle **349** on inquiry card.

VALVES

Safety Valves

New high-capacity safety valves of simplified design, in sizes from 2-in. to 6-in.; operate on line pressure principle and do not require use of

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SUB-ARCTIC INDUSTRIAL CABINETS

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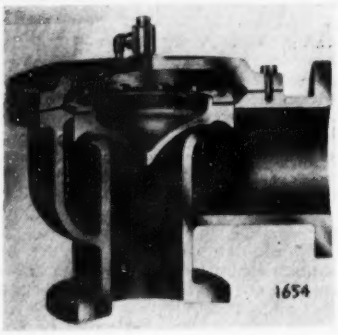
For more information circle **95** on inquiry card.

NEW INSTRUMENTS

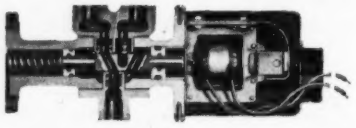


large springs. Test capacities range from 75 to 85 percent of open-nozzle flow. Liquid and vapor service, pressures from 100 to 200 psig. Feature: valve can be operated manually or automatically; opened or closed or regulated at valve or at a remote location.—*The Controlled Flow Valve Co., 9th and Baltimore, Kansas City, Mo.*

For more information circle **350** on inquiry card.

Solenoid Valves

New "Shear-Seal Solenoid Valves" for 0 to 250 psi. oil service incorporate "Shear-Seal" principle; are not

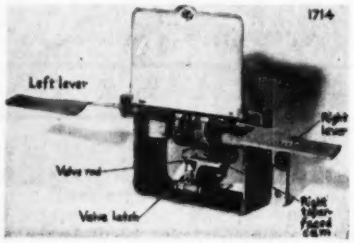


critical to pipe scale or other foreign material in liquid because lapped sealing members are in constant contact: square-corner wiping action pushes dirt aside and lets it flush out through return port. No "wire drawing" or scoring because flow is through sealing members and never across sealing surfaces. Available in ¼, ⅜ and ½-in. pipe sizes, in 4-way, 3-way, and shut-off models for 110, 220 or 440 v.ac.—*Barksdale Valves*, 5125 *Alcoa Ave., Los Angeles* 58, *Calif.*

For more information circle **351** on inquiry card.

Two-lever Air Valve

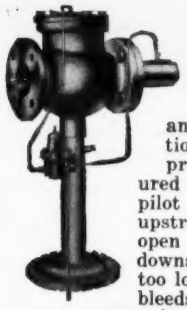
New "Two-Lever Coordination Control" comprises an air valve and two extending levers, interconnected through linkage which opens valve only when both levers are operated. It can be arranged so that levers must be actuated (a) simultaneously, (b) in sequence of a given order, or (c) in sequence of any order, to open valve. In all cases both levers must be operated before valve will open. A similar variety of conditions can



be prescribed to close the valve. Overall length 23½ in. Designed for max. air pressure of 125 psig.—*Pantex Mfg. Corp., 521 Roosevelt Ave., Pawtucket, R. I.*

For more information circle **352** on inquiry card.

Steam Reducing Valve

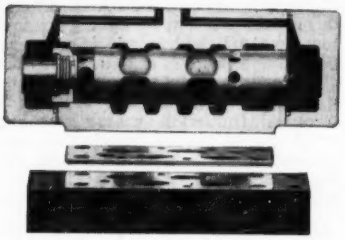


New "No. 933" pilot - operated steam reducing valve features easily-made pressure adjustments and simple operation. Downstream pressure is measured by diaphragm of pilot valve. Pilot uses upstream pressure to open main valve if downstream pressure is too low; if too high, it bleeds off to allow main valve to close as required. Action is accomplished without appreciable variation in downstream pressure. Sizes from ¾ in. to 6 in.—*Klipfel Valves, Inc., Hamilton, Ohio.*

For more information circle **353** on inquiry card.

Gasket Mounted Valve

New "Series 6600" gasket-mounted solenoid-operated 4-way valve is fully shock resistant because of valve spool of a scalloped design, which opens or closes gradually—increasing or decreasing areas to ports as spool is moved left or right. "Series 6600" is designed for 3000 psi. oil hydraulic service; meets all J.I.C. requirements. Two basic valves can be used for five sizes. Solenoids operate on 3.6 amps. inrush and 0.45 amp. holding at 115 v. Pilot valve (¼-in.) may be used as a direct solenoid valve by itself for control of 3000 psi.—*Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.*

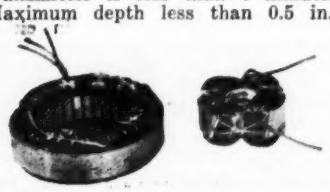


For more information circle **354** on inquiry card.

MISCELLANEOUS

Aircraft Gyro Synchro

New "Type SG-17-1-A" synchro is designed for gimbal mounting in airborne gyroscopic instruments. Maximum error spread when used as a transmitter is less than 6 minutes. Maximum depth less than 0.5 in.;



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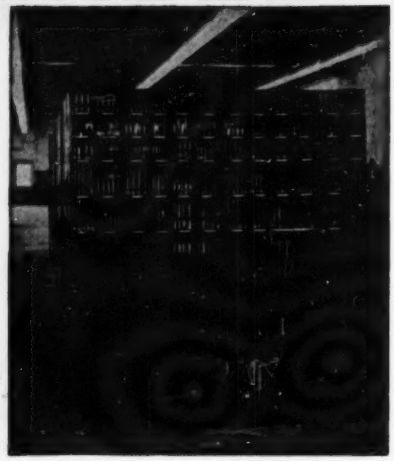

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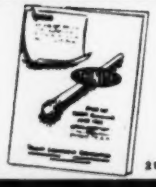

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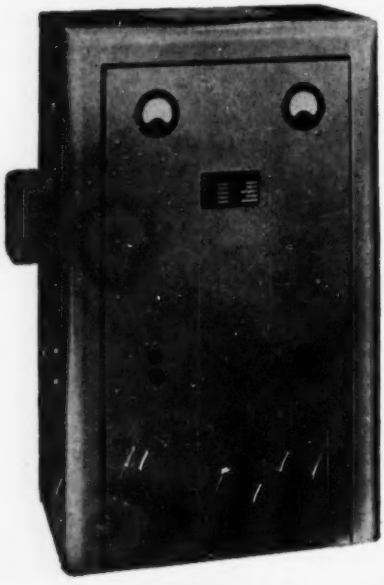

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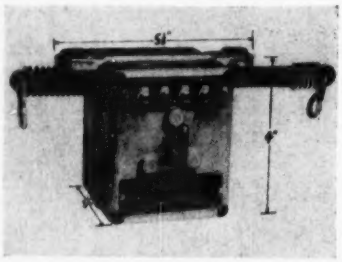
NEW INSTRUMENTS

over-all diam. is 1.625 in. Rotor input to synchro is 26 volts 400 cps.; stator output is 11.8 volts. Input power when loaded with one control transformer is 0.973 watt; sensitivity at control transformer output is 397 mv/deg. New synchro reflects to its shaft no measurable cogging effects, or mechanical loading.—*Clifton Precision Products Co., Inc., Marple at Berkley, Clifton Heights, Pa.*

For more information circle **355** on inquiry card.

Straight-line Action Power Unit

New "No. 311 Safe Return Motor" operates dampers, switches and other control devices by converting power



taken from drive shaft of a high-speed fractional-hp. induction motor into lateral motion through a rack that can be made to travel up to 12 in. either left or right. Rack is returned to normal position by spring or counterweight when circuit is de-energized. Chief advantage is that unit will handle heavier loads than solenoids: it will lift approx. 25 lbs. 4 in. in 30 seconds. Induction motor (maker's own) can be stalled indefinitely without harming it.—*Gleason-Avery, Inc., 45 Aurelius St., Auburn, N. Y.*

For more information circle **356** on inquiry card.

Synchronous Contactor

New "Rototimer" coordinates angular position of a rotating shaft and opening or closing of an electric circuit; comprises a cam-operated s.p.d.t. switch than can be externally ad-

justed through 360 deg. in either direction from any starting position. Adjustment by a handwheel and 25-to-1 worm gear. Operate point of switch can be adjusted while connected machine is in motion.—*Farmer Electric Co., 21 Mossfield Road, Waban, Mass.*

For more information circle **357** on inquiry card.

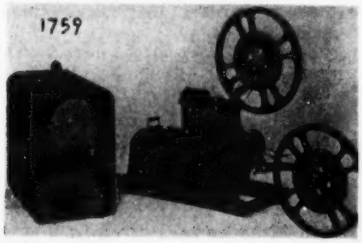
Supersonic Machmeter

New Supersonic Machmeter continuously indicates Mach Number within range of 0.7 to 3.0; complements maker's subsonic (0.3-1.0) and transonic (0.5 - 1.5) Machmeters. Essentially it is a mechanical computer, operated by impact and static pressures furnished by a Pitot tube. —*Kollsman Instrument Corp.*, 80-08 *45th Ave., Elmhurst, N. Y.*

For more information circle **358** on inquiry card.

Transistorized M-p. Projector

New "Model 477-R" optical-magnetic "playback" projector, said to be "the latest development in the new

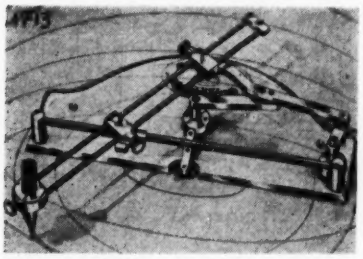


field of magnetic recording on 16-mm. film," can also project standard silent and optical-sound films; one-case unit, with 8-in. speaker.—*Ampro Corp.*, 2835 *N. Western Ave., Chicago, Ill.*

For more information circle **359** on inquiry card.

Ellipsograph

New "Omicron Ellipsograph" has a capacity of over 12 in. major axis. Within its capacity all sizes, shapes and projections of ellipses can be pro-

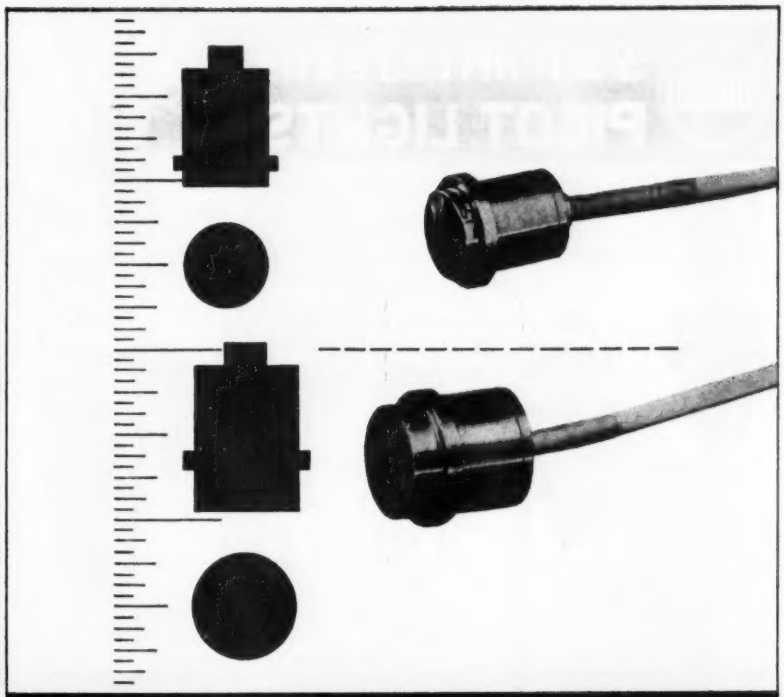


duced with pencil, inking pen or scriber. Feature is a linkage system which moves cross guide pin on a straight line: said to eliminate all play and friction usually associated with slides.—*The Omicron Co., P.O. Box* 907, *Glendale, Calif.*

For more information circle **360** on inquiry card.

Automatic Controller for Engine-and-generator Sets

New "Engine-Generator Control" for use with diesel- or gasoline-driven sets, is classed as "demand start, load start, fully automatic lamp start control." Principal features: (1) Load itself starts engine and plant stops



CEC miniature "star type" pressure pickups give stellar performance

Combining unusually small size with direct sensing diaphragms that permit flush mounting to eliminate turbulence or cavity resonance effects, CEC's 4-310 and 4-311 "star type" pressure pickups are unsurpassed for gage pressure measurements in the 5 to 5000 psi range. The outstanding hysteresis and linearity characteristics of these variable resistance instruments make them widely applicable in recording, indicating and controlling circuits. Wide temperature range permits use from −100 to +250° F. Their response to acceleration and vibration is negligible. Either A-C or D-C excitation may be applied to these pickups. Stainless steel construction withstands corrosion in extreme environments. The versatility of CEC's miniature "star type" pressure pickups makes them ideally suited for such applications as aerodynamic pressure surveys and other high frequency liquid or gaseous pressure studies. Send for Bulletin CEC-1503P-X1.

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Sub-Miniature PILOT LIGHTS

A great aid to miniaturization

Require a single 15/32" hole

All lens colors

All units applicable to Mil Specifications

when you're CRAMPED for SPACE

A) PLASTIC PLATE LIGHT ASSEMBLIES

B)

C) LIGHT SHIELD ASSEMBLY

D) E) SUB-MINIATURE INDICATOR LIGHTS

A) No. TT-51; No. TT-51A with No. 327 lamp. For edge lighting. Red or other color filters, black top.
B) No. 8-3730-111; for Mil-7788 panels.
C) No. 4-1930; light shield.
D) No. 8-1930-111; non-dimming.
E) No. 11-1930-111; mechanical dimmer. No. 3-1930-111; polaroid dimmer.

All assemblies accommodate midget flanged base lamps like this one *(actual size)*; easily replaced. Available for voltages of 1.3, 2.7, 6, 14, and 28.

Any assembly available complete with lamp.

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Foremost Manufacturer of Pilot Lights

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For more information circle **100** on inquiry card.

EXPLOSION PROOF

Temperature Limit Controls

The Burling Model V-1-X temperature control has two concentric tubes of different materials exposed to the heat. The relative motion of these, operates a snap-action switch through a lever. Entire unit except tubes, is mounted in an explosion proof housing.

Model V-1-X

Features of Other Burling Controls

- Ranges from −300°F to +1800°F
- Electric or Pneumatic
- One, two or three Micro Switches
- Differential Expansion of Solids No Liquids nor Gases.
- For controls, safety-alarms, cut-outs.

Send for Bulletin 102

Burling Instrument Co.

9 Vose Avenue,

South Orange, N. J.

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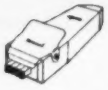
ACROMARK FOR

HERCULES HOLDERS and Shoulder Style Steel Type for numbering.



Model HN Numbering Machines —Hand Style. All numbers on each wheel.

SPEED Model Numbering Machines for consecutive or random numbering in a press.

ACROMARKER Name-Plate stamping machines are made in several models and sizes for hand or foot operation.

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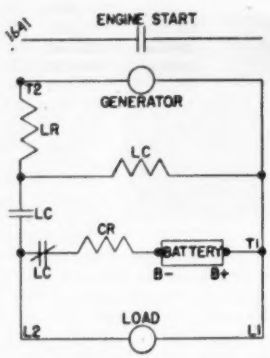
NEW INSTRUMENTS

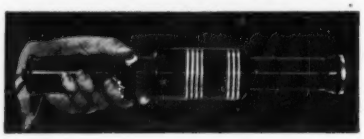


when all loads have been turned off; (2) built-in protection prevents stalling; (3) no delicate parts or critical relay adjustments. Present ratings 2 to 18.75 kva. (open or enclosed); minimum starting loads from 60 to 100 watts for 2- or 3-wire generators. —*Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.*

For more information circle **361** on inquiry card.

Projection Pointer

New "Projection Pointer" enables a lecturer to cast a sharp, color-free



arrow image from any point in auditorium, has feather-touch momentary switch; operates on 115 v.ac. with built-in transformer; is Underwriters approved.—*Ednalite Optical Co., 200 North Water Street, Peekskill, N. Y.*

For more information circle **362** on inquiry card.

SO_2 Detector

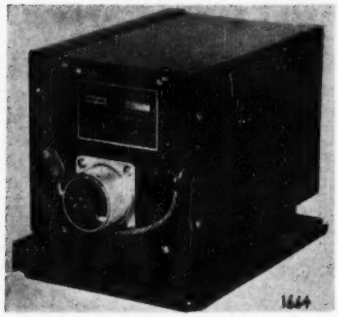
New "Sulphur Dioxide Gas Detector" quickly determines SO_2 concentrations of 0 to 50 ppm. in a working-

area atmosphere. User squeezes aspirator bulb three times, then reads the SO_2 concentration on scale.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **363** on inquiry card.

Low-voltage Safeguard

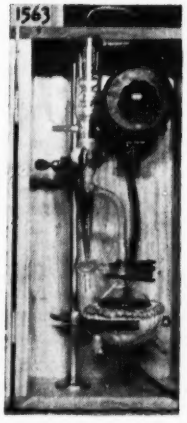
New "Voltage Sensitometer" protects aircraft electronic equipment or controls which might not operate properly on low voltage or which might be sensitive to voltage fluctuations or failure of aircraft power supplies. Upon a predetermined drop of voltage, it either locks or shuts off



the equipment it is protecting. It also senses when power supply is reestablished and, after a time delay, it either unlocks or turns protected equipment back on. In industry, it will control any function which can be converted to varying voltage: speed, flow, pressure movement, etc.—*Electronic Specialty Co.*, 3456 *Glendale Blvd., Los Angeles* 39, *Calif.*

For more information circle **364** on inquiry card.

Moisture Determinator



New "Moisturescope" for moisture determination using xylol distillation method fits all of A.O.A.C. requirements; enables rapid moisture determinations to be made any place within the plant where there is running water and 115 v.a.c. No dismantling is required for storage. A technician can be trained to run it in 5 minutes or less. Distillation flask cannot freeze to trap. Sample may be easily introduced and removed. Case serves as a wind and draft guard to permit uniformly rapid distillation rates.—*Hafco, P. O. Box* 699, *Westfield, N. J.*

For more information circle **365** on inquiry card.

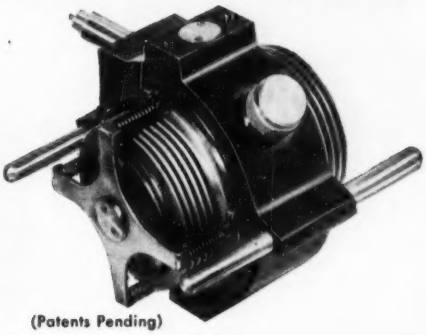
Light-intensity Control for Photoelectric Relays

New models of maker's light sources have built-in dimming resistors, prolonging service life of lamps and of phototubes.—*The Autotron Co., Box* 722Q, *Danville, Ill.*

For more information circle **366** on inquiry card.

IIC flow meters

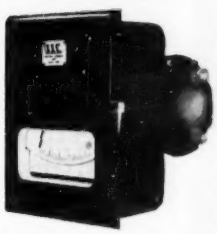
WITH FEATURES THAT MAKE A REAL DIFFERENCE IN SERVICE



(Patents Pending)

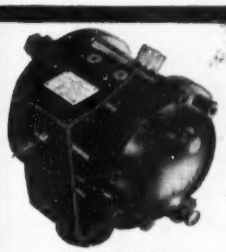
1. Greater power, longer-calibrated travel for assured accuracy.
2. One-piece seamless, type 316 stainless steel bellows. No pitting, no welds, longer life. (Monel bellows can be furnished for special services.)
3. An exclusive I.I.C. development, the patented free floating Non-Freezing Instrument Bearing, makes possible a new era in flow meter accuracy.
4. Differential obtained from actual displacement of fluid and not from stem movement.
5. Over-range protection to housing rating.
6. Pulsation may be dampened in service without special tools.
7. Complete compensation for wide range of ambient temperatures.
8. All standard ranges available: 0-10" H_2O to 0-300" H_2O.
9. Working pressures up to 5,000 psi.
10. No precise leveling required.
11. Self-draining. No seal pots required.

Model 802 Recorder
(Patents Pending)
IIC Model 802 Recording Flow Meter is actuated by Model 700 Meter Unit.
Simple installation. Built by experienced instrument men from a simple design, engineered for rugged duty.



Model 800 Indicator
(Patents Pending)
IIC Model 800 Indicator is actuated by Model 700 Meter Unit, is calibrated in same manner as Model 802 Recorder.

Model 800-6 Indicator
(Patents Pending)
IIC Model 800-6 Indicator is actuated by Model 700 Meter Unit. Standard 6" dials available in uniform, square root, as well as other special ranges.



Model 700 Meter Unit
(Patents Pending)
The new standard of quality for metering devices, the Model 700 Meter Unit is used by other instrument manufacturers to actuate their own differential pressure recorders, indicators, controllers and transmitters.

Write for Bulletin 56-B

INDUSTRIAL INSTRUMENT CORP.

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For more information circle **103** on inquiry card.

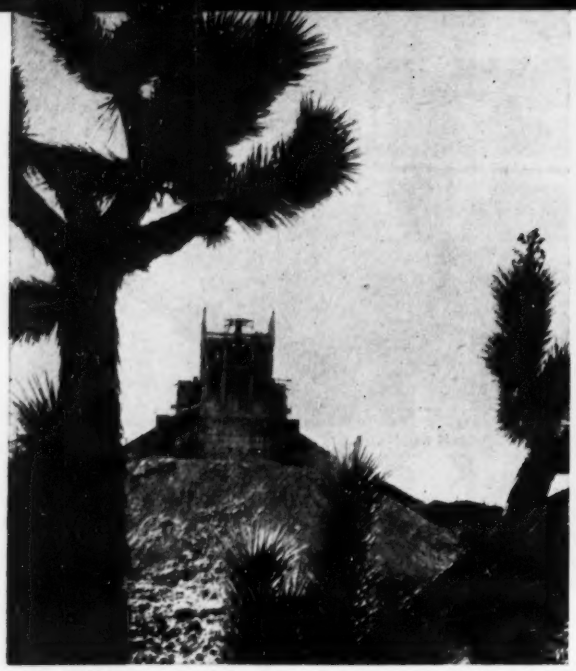


Fig. 1. Joshua trees on the desert floor frame a static-thrust stand of the Experimental Rocket Engine Test Station, Air Force Flight Test Center, Edwards Air Force Base, Calif. The cylindrical object in the center of the stand is a propulsion system ready for firing.

Fig. 2. Perched precariously on a rocky hillside, static-thrust test stands at the Experimental Rocket Engine Test Station, Air Force Flight Test Center, are built with footings penetrating as deep as 60 feet into solid granite.

Fig. 3. Tests conducted by the Experimental Rocket Engine Test Station, Air Force Flight Test Center, require extremely accurate measurements and records. The instrumentation is housed in a shockproof, dustproof building near the center of the technical area.

Fig. 4. An engineer of the Experimental Rocket Engine Test Station of the Air Force Flight Test Center observes a test through the optical viewer. Flame patterns produced by the engines are extremely important in evaluating test firings, and several motion-picture cameras record each wiring.

Instrumentation of ROCKETS &

FAR out in the wind-swept vastness of the Mojave Desert in Southern California, the scattered buildings of the Experimental Rocket Engine Test Station (ERETS) stand in mute testimony to the unceasing efforts of the United States Air Force to overcome the increasingly complex problems of rocket-powered flight. Built on a series of sun-baked granite ridges, the huge test stands, gleaming, odd-shaped propellent storage tanks, and squat, one-storied buildings provide a bizarre contrast to the miles of uninterrupted desert surrounding the Station.

Operated by the Rocket Branch of the Engineering Laboratory, the Experimental Rocket Engine Test Station is under the control of the Air Force Flight Test Center, Edwards Air Force Base, Calif. This Center is one of nine research, development and testing Centers of the Air Force's Air Research and Development Command, which has its Headquarters in Baltimore, Md. While the primary mission of the Air Force Flight Test Center, commanded by Brig. Gen. J. Stanley Holtoner, is the flight testing of aircraft and component parts, liquid rocket engine tests at ERETS often parallel flight tests of prototype missiles and aircraft conducted at the Flight Test Center itself. As more and more modern aircraft utilize rocket engines to increase take-off or flight performance, and with the increasing emphasis on guided and ballistic missiles, the tests and research conducted at the Rocket Test Station is of vital importance.

The Rocket Test Station itself is scattered over a series of granite ridges overlooking the desert floor. By far the most prominent structures are the huge cement and steel static-thrust test stands. Perched precariously on the edge of a sheer cliff, the stands are built to withstand the strain of many thousands of pounds of thrust acting vertically. Missiles or rocket engines fit comfortably into the steel mounting cradles. To prevent damage to the cement by the extremely hot blast of large rocket engines, a water deluge system is installed which floods the base of the stand with a cooling stream of water. A similar emergency system is built into the test stand itself.

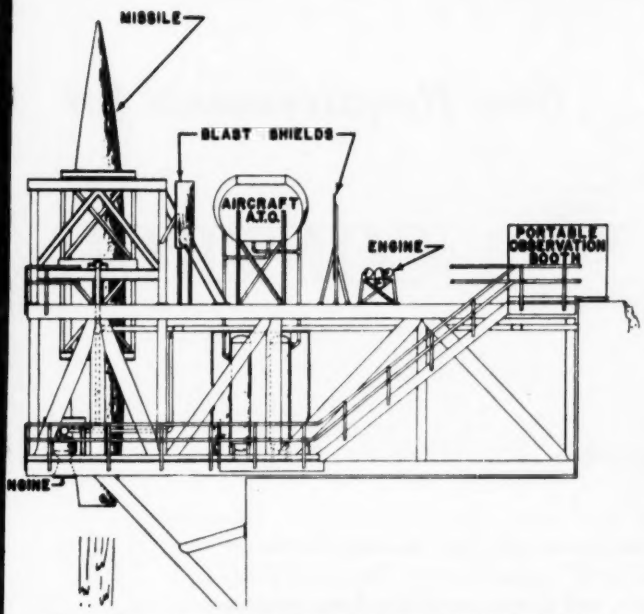


Fig. 5. The test stands of the Experimental Rocket Engine Test Station of the Air Force Flight Test Center are designed to accommodate tests of several rocket engines within a short period of time. Blast shields protect the different engine installations from effects of nearby runs.

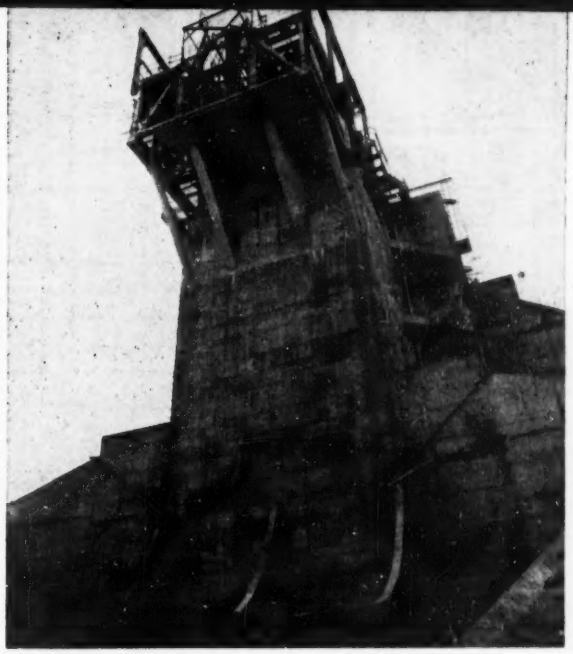


Fig. 6. Test stand of the Experimental Rocket Engine Test Station. Tremendous strains are put on the test stands by firings of large rocket engines.

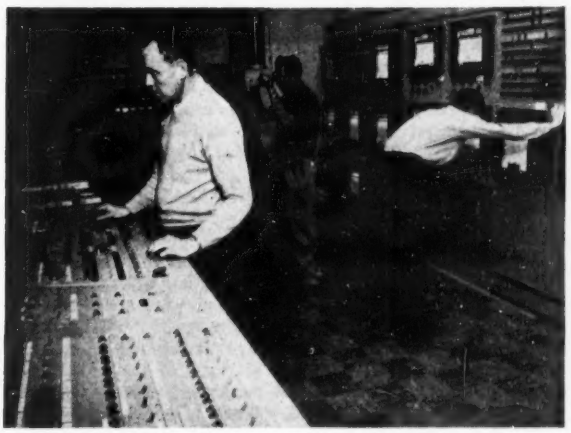


Fig. 7. All firings are controlled from the Central Control Room. The engineer in charge stands at the Control Console ready to operate the firing switch, while in the background an engineer is using a periscope to observe the flame pattern, and a technician checks one of the recorders.

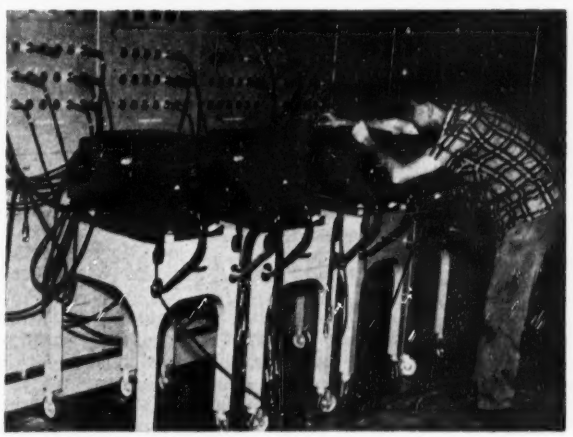


Fig. 8. Oscillographs are used at the Experimental Rocket Engine Test Station to record sudden changes in instrument reading. Here an engineer checks a bank of oscillographs at the instrumentation cubicle in the Central Control Station.

& MISSILES

Since the object of tests at the station is to approximate as nearly as possible conditions encountered in free flight, as many such factors as are practical in static tests are simulated. As rockets, and other more conventional engines, operate differently at varying attitudes, the mounting cradles may be tilted. Equipment to simulate other flight conditions, such as reduced pressure and extremely high or low temperatures, is presently in the planning stage. Tests at ERETS are under the direction of Mr. Donald L. Dynes, Chief of the Test Operations Section.

In an effort to increase the efficiency of the stands, provision is made for mounting more than one engine on each stand at once. Although the engines are not operated simultaneously, this arrangement enables the time lag between tests to be cut. Steel shields protect the engines from the effects of nearby runs. The test stands themselves incorporate provisions for fuels and oxidizers necessary for extended runs (ordinarily the propulsion systems contain complete fuel systems for normal tests), as well as all associated equipment necessary to perform a rocket engine run. During actual tests, however, the control is maintained by another ERETS installation, the Central Control Station, located midway between the test stands.

The Control Station represents one of the greatest concentrations of data recording equipment ever installed for the development of a power plant. From the Control Station, engineers control the firing and runs of the engines mounted on the test stands. Any of the recorders and control switches can be connected to either test stand. As a major test often requires hundreds of records, any of the permanently installed recorders, oscillographs and control panels are available for the use of the organization conducting the test, and all can be connected to circuits on either test stand. Both optical and direct viewing of the stands and surrounding area is available from the Control Station, while elaborate safety features prevent injury of personnel by explosions or toxic gases.

New Requirements for

CONTROL

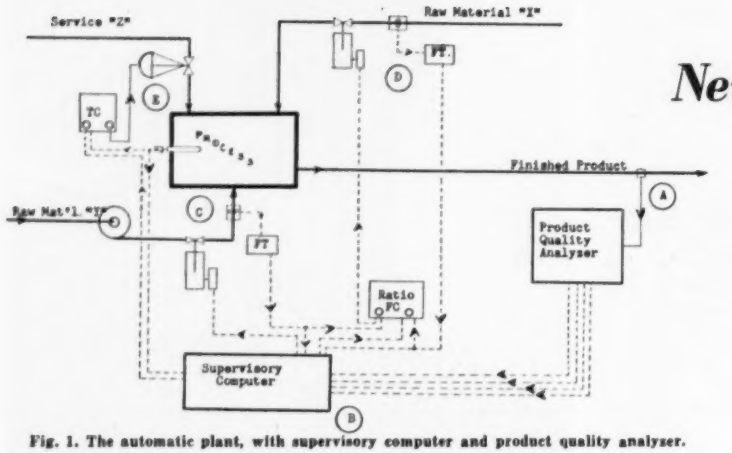


Fig. 1. The automatic plant, with supervisory computer and product quality analyzer.

Future processes will feature higher throughputs and less material in storage —necessitating high-speed "cycles-per-second" control, more powerful final-control elements, faster primary elements, and dynamics-designed equipment.

COMPLETE AUTOMATION of a chemical process implies closing the over-all control loop to feed back quality data, as shown through A and B in Fig. 1—by mechanisms, not human manipulation. Operators then can be released from routine operation and elevated to preventative monitoring, supervisory inspection, and emergency operation only.

Three domains of instrumentation are indicated:

1. Instrumentation that will automatically and continuously report product quality, as at A. This is probably the weakest link at present and seems likely to be the most difficult to develop and to justify economically.

2. Instrumentation, as at B, called "Supervisory Computer." A start has been made on the problems involved.

3. Monitoring instrumentation to monitor the individual variables, as at C, D, and E. This type of instrumentation now dominates process control work, but present-day techniques may need revision if plants are completely automatized.

Note also that at C and D the control-valve positioner is not the conventional symbol, as will be discussed.

There are two additional and important points of emphasis—(1) future plants, completely automatized or not, will probably have much higher throughput rates, and (2) the amount of material in storage within the process will be reduced. These two criteria give important clues to the future, and are even now placing new requirements on both primary elements and control equipment.

Response Speed

Increased speed of response will become imperative. Without "hold-up" to average and balance out fluctuations, corrections must be made faster and more precisely. Deviations at frequencies now regarded as "noise" will become measured data, and corrections must be made at corresponding frequencies. Interlocks and "dumps" also may be required to act faster.

Ability of equipment to operate with rapidly deviating variables is conveniently estimated by use of *frequency-response curves*, which technique will find wider application in the near future. These curves are obtained by varying an input variable sinoidally, and measuring the output magnitude and time lag as the number of variations per unit time is gradually increased. The signal reduction, or attenuation, may limit the frequency at which equipment can be applied; the phase-shift, which reflects the time lag in the equipment, also limits the frequency at which equipment can be used.

Note that a fixed time lag becomes an increasingly greater phase shift, in degrees, as frequency gets higher. Dead time is a nuisance now, but at the higher frequencies of the future it must be eliminated.

Final Control Elements

Final control elements for future higher frequencies may require new designs. As faster response requires more power than is provided by conventional pneumatic valves, more use will be made of positioners and booster relays with larger ports fed by larger and perhaps higher-pressure air-supply lines. Wider use of hydraulic positioners seem likely. Such units, for fairly heavy duty, already have been constructed for valve operation up to 5 cycles per second, with positioning precision within 0.02 percent of full travel. This shift to faster and more powerful valve operators may be accelerated by the trend towards higher operating pressures.

Primary Elements

Frequency-response requirements also will force a critical review of many primary elements and their associated transducers. At present, low-pressure pneumatic systems and pneumatic-signal pickups enjoy dominance in chemical processing. Some of these are limited to operation frequencies below several cycles per minute. Transducers providing electrical signals are more attractive from a frequency-response viewpoint; their wider use must be anticipated unless higher-speed pneumatic systems are developed.

The recent introduction of the all-electric controller of graphic-panel size may be one fore-runner of tomorrow's controller for "cycles-per-second" control. However, no satisfactory all-electric valve operator is on the horizon, and thus another transducer—either electric-to-hydraulic or electric-to-pneumatic—is required. Such transducers already have been designed with frequency-response characteristics that permit "cycles-per-second" operation.

Package Design

Higher plant throughput rates will accelerate the "package" design wherein interchangeable units can be removed and plugged in quickly. Hand operation of plants at cycles-per-second speeds is not feasible and, as every minute away from control point represents spoiled product, it will be-

*Presented before the New York section ISA Winter Conference meeting, New York, Feb. 18, 1953.

EQUIPMENT

by C. R. OTTO
E. I. DuPont de Nemours & Co.

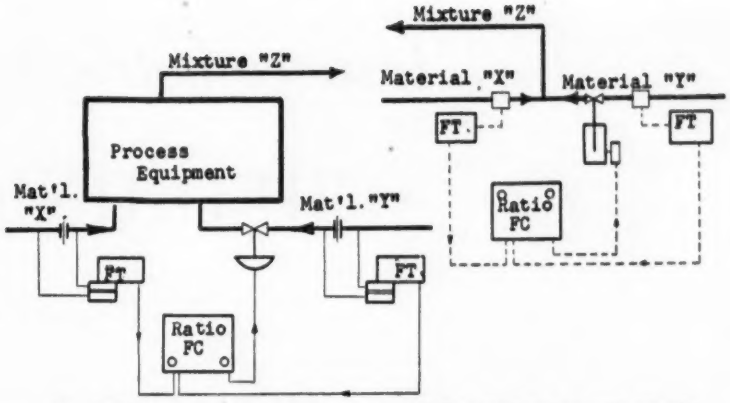


Fig. 2. Ratio control process. Left, conventional slow-speed process with material in storage; right, high-speed system with no material in storage.

come uneconomical to make any but minor adjustments in the field. Instead, precalibrated replacement units will be plugged in, and repairs will be made in the shop or manufacturer's factory. This trend is already in evidence.

Supervisory Computer

The *supervisory computer* will perform the routine functions of present-day Production Supervisors. Receiving information on each individual variable and on each aspect of quality, the computers will decide which variable is to be adjusted, and will correct the set point of the corresponding controllers. Note that the computer in Fig. 1 receives data from monitoring instruments as well as from the product quality analyzer. The computer will analyze all this data and compute the control adjustments required.

Product quality analysis is now a weak link in the loop. The major difficulty often lies in a specific definition of the factors that contribute to acceptable quality—molecular weight, viscosity, specific gravity, color or transparency, absence of inclusions or hard spots, shear strength, elasticity, and others may all have to be evaluated continuously, simultaneously, and automatically to realize complete automation. Sampling is another problem; the ultimate might be analysis elements that can be installed directly in the process piping rather than bringing a sample to the analyzer.

There has been much recent development in infrared analysis, color measurement, spectrographs, and other quality-analysis instruments. Many of these are not automatic as yet; however, they must be made so for the fully automatized plant with a supervisory computer.

Process Dynamics

To operate a controlled system at higher frequencies demands that the processing equipment itself be adaptable to the higher frequencies. Process engineers must become "dynamics" conscious and build accordingly, particularly with regard to the time lags in terms of phase shift. If the fully automatic plant is to be realized, engineering schools must provide more training for all engineers on dynamic analysis and instrumentation. Post-graduate training on the job must be extended in the same fields. New design techniques must be accepted—process equipment must be designed because of dynamic behavior, not static qualities. More evaluation of the dynamic qualities of existing process equipment would be valuable. Manufacturer's data on frequency limitations of commercial equipment such as blowers, heat exchangers, etc. should be catalogued more extensively, especially phase shift.

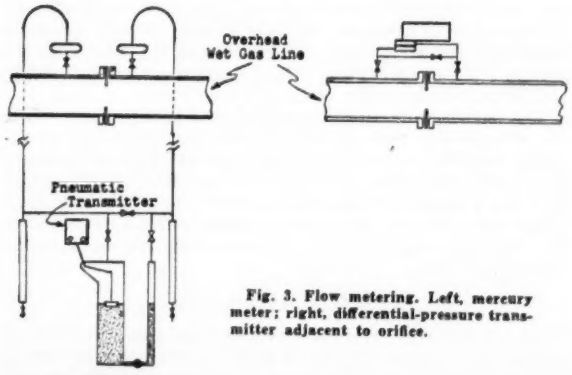


Fig. 3. Flow metering. Left, mercury meter; right, differential-pressure transmitter adjacent to orifice.

Examples of Modern Improvements

In Fig. 2, with hold-up as in the left figure, the transmitters on both X and Y could be damped considerably, and the average mixture at Z would remain reasonably good. Z can be changed only slowly, however. Without hold-up, as in the right-hand figure, it is essential that all pulsations be followed if the mixture at Z is to be consistent. Note the savings in process equipment realized by eliminating hold-up.

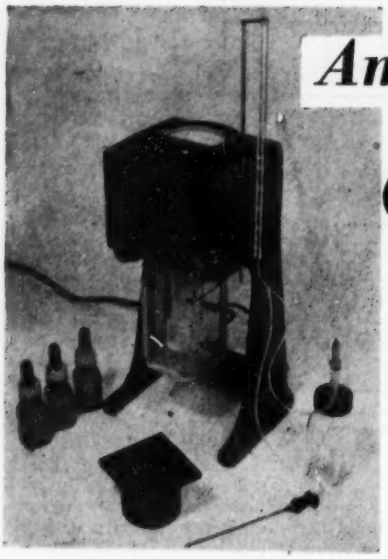
In Fig. 3, a mercury meter on wet gas might be installed, or a differential-pressure transmitter can be installed adjacent to the orifice. Higher-frequency operation is gained in two ways in the latter system. First, the heavy mercury and relatively massive float, with their inherently low natural frequency and necessary heavy damping, are eliminated. Secondly, most of the storage capacity and flow resistance of the meter runs is eliminated. The reduction in attenuation and especially in phase lag make modern pneumatic transmitters appropriate for "cycles-per-minute" operation. However, for "cycles-per-second" operation, electric transmitters are essential.

Several modern electric flow-sensitive elements are available. One is the "Potter" flow-sensitive meter with internal rotor. Others are the Mittelmann and Vitro meters, which eliminate all moving parts and substitute only two diametrically opposed button electrodes. Broding's patent (No. 2,583,724) even eliminates the internal electrodes. Prof. Li, of M.I.T. has introduced a rotative true mass-rate meter with a natural frequency of around 600 cps.

In summary, the new requirements on tomorrow's instruments will stem from operation of tomorrow's plants at higher frequencies and greater precisions, with higher throughput rates and less hold-up. Instrumentation is entering a new order of responsiveness and power levels. Along with this, instrumentation costs will become an increasingly larger percentage of plant investment.

Acknowledgment

The author thanks W. A. Crawford, F. H. Trapnell, L. N. Combs, E. F. Kremer and C. A. Hill for assistance.



Amperometric techniques for CHLORINE RESIDUAL

by GEORGE C. CLARK, JR.
Wallace & Tiernan, Inc.

Colorimetric and amperometric techniques are in use for measurement of residual chlorine content of water. The three colorimetric techniques are presented; the newer amperometric technique is described in detail, including detection cells.

Fig. 1. Amperometric titrator.

RESIDUAL CHLORINE in water can be measured in four ways. Three are colorimetric in principle; the fourth uses amperometric technique.

Colorimetric Methods

The most widely used method is the *Orthotolidine test*, which involves the reaction of orthotolidine with chlorine to produce a color that depends on the amount of residual chlorine in the sample. The color is compared to colors of a graduated set of known standards to get the value of residual in the sample in terms of total chlorine residual.

A refinement of this is the *orthotolidine-arsenite*, or OTA, test. This is based on the fact that full color is developed from the reaction between Orthotolidine and free residual chlorine almost instantly. Sodium arsenite is added to the test sample within 5 seconds after the OT is put in to reduce the combined chlorine residual present. The color produced is compared with standards and the answer is some value of free available chlorine residual. In a second sample of the same water, no arsenite is added and the OT is allowed to develop its maximum color to reach a figure for total chlorine residual. The difference between the two answers is the combined chlorine residual.

These tests have various inherent sources of error, some of which can be compensated for. They include false color due to manganese or iron, turbidity in the sample, variations in the light source, simultaneous development and fading of the color, fading of the so-called permanent standards, and human error. These two tests are used widely because of their convenience and ease of performance, and because the greatest range of color change for different residuals is in the scale of residuals (up to 2 or 3 ppm.) usually found in water plants.

A third method is the *starch-iodide test*, which involves titration to a colorimetric end point, and which is best for values of chlorine residual much higher than normally encountered in potable water.

Amperometric Techniques

The fourth and newest way of determining chlorine residual is by *amperometric titration*. This depends on the ability of a reducing agent, phenylarsene oxide, to react quantitatively with free chlorine or free iodine over a wide pH range, but not to react with combined chlorine. The oxidizing action of the free chlorine or free iodine on a platinum-silver cell produces a current which is indicated on a microammeter in series with the cell. As phenylarsene-oxide solution is added in small increments to the continuously stirred sample, the current decreases and the meter needle deflects down scale. The end point of titration is reached when one increment produces a deflection and the next addition produces no movement. As the phenylarsene oxide is of such normality that 1 ml. will just neutralize 1 ppm. of free chlorine, and as 1-m. burette graduated in hundredths is used, the answer in ppm. Cl_2 may be read directly from the amount of phenylarsene oxide used to reach the end point. Higher normalities can be used if higher values of residual chlorine are to be measured.

Determination of combined chlorine residual is based on the ability of chloramines to release free iodine quantitatively from potassium iodide. The free iodine released is titrated exactly as before and the answer is read as combined chlorine. A further refinement is due to the fact that at pH 7, only monochloramine will release iodine from KI, whereas at pH 4 both monochloramine and dichloramine will perform the release.

The procedure for determination of each of the three fractions of residual chlorine (if all are present in one sample) is as follows. In a 200-ml. sample, the pH is adjusted to 7 with 1 ml. of phosphate buffer, and the titration is performed to an end point, which gives the amount of *free chlorine* which was present. Then 0.2 ml. of a 5-percent KI solution is added, and titration proceeds to a second end point. The difference between this value and the first is the amount of *monochloramine*. The pH then is adjusted to 4 with 1 ml. of acetate buffer, an extra 1 ml. of the 5-percent KI solution is added, and the sample is titrated to a third end point. The difference between this and the second is the amount of *dichloramine*, and the amount of phenylarsene oxide used for all three is the measure of the *total chlorine residual*. If only the total residual is desired, the pH 4 buffer and KI are added to the sample at the outset.

The technique is easily mastered, and errors which affect the colorimetric tests do not appear. Turbidity can be ignored, metallic ions such as manganese and iron do not react at the pH levels where the titrator is operated, the pH values of 7 and 4 are not critical and may be half of a pH unit on either side, and the phenylarsene-oxide solution is stable at the normality used. With practice, answers may be obtained within 0.01 ppm.

Continuous Recording

As the tests for residual chlorine improved, and as the nature and characteristics of small concentrations (up to 10 ppm.) of residual chlorine in water became better under-

Presented at conference on Industrial Instrumentation In Water Sewage and Industrial Waste treatment, May 14, 1953, Manhattan College, N. Y.

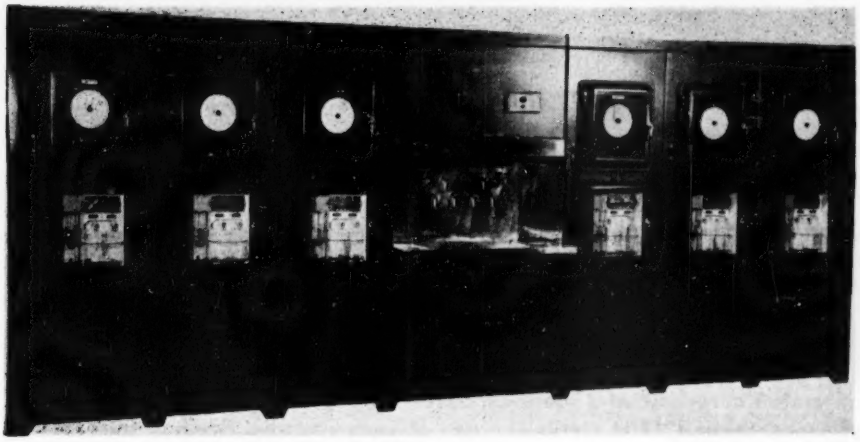


Fig. 2. Multiple amperometric residual recorder, incorporating high- and low-residual alarms, both audible and visual.

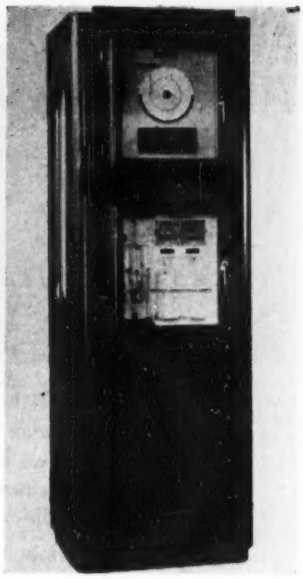


Fig. 3. Amperometric residual recorder.

stood, the desire arose for a device to record this residual along with water flow, pressure, and level recorders. The best-run water plants making residual determinations with orthotolidine may take a test every half-hour, but that is rare. Once an hour is more usual and many plants are satisfied with one to three tests a day, maybe one a shift. Even though the periodic tests indicated that the residual was at the required level, there was no way of knowing whether the residual was steady or was rising or falling, and it was not economical to have a man make test after test for eight hours. This condition made a continuous recording device for chlorine residual highly desirable.

The first approaches to this problem involved use of photoelectric cells to measure and record intensities of color produced by the addition of reagent. However, errors were inherent in the colorimetric methods and accumulation of slime on the water cell affected the readings.

Wallace & Tiernan's research approach was along electrochemical lines; various types of cells such as potential and polarization cells were tried. Out of this was developed the present arrangement which uses a platinum-alloy and copper cell, with the electrodes mounted coaxially so that the sample water flows through the cell continuously. This has proved successful on a wide variety of waters.

When operating conditions are fixed, the cell produces a small d-c. current proportional to the amount of free chlorine or free iodine present in the sample. This current is measured by a recording microammeter in terms of ppm. of chlorine. To prevent the cell from being fouled by slime or chemical deposit, provision is made to recirculate continuously a quantity of abrasive grit which keeps the electrodes clean. The cell has a temperature coefficient and a pH coefficient. The change in current with a change in temperature for a fixed residual is mathematically predictable and is compensated for by manual setting.

Calibration

The recorder can be calibrated to any full-scale range; standard charts have a range of 0 to 1, 0 to 2, or 0 to 5 ppm. The calibration procedure entails making the reading correct at two values of residual far apart on the chart. One of the values usually used is zero; the other is that of the residual in the water arriving at the recorder location. The zero value is used so that any slight current due to materials other than chlorine can be compensated for. None of the substances usually found in potable water supply will create a current that is more than a tiny percentage of that due to free chlorine or free iodine, and this so-called zero current can be compensated for in the recorder circuit. As zero Cl_2 residual water is rarely available under pressure, a simulated zero residual test has been devised for calibration.

Uses

The residual chlorine recorder serves many useful purposes. Trends are revealed. When used in conjunction with the prechlorinator in a filter plant, the sample water to the recorder can be taken after the mixing chamber, or at the outlet of the sedimentation basin. Sudden increases in chlorine demand in the raw water will be seen and appropriate steps may be taken before too much of the water is in the plant. One filter plant which practices free residual chlorination on river water applies chlorine in the low-lift-pump suction and samples for the residual recorder from the pump discharge, maintaining about 1-ppm. free chlorine residual after 5 minutes' contact time. On one occasion the residual dropped abruptly to zero and full capacity on all chlorinators failed to produce a free residual; the plant was shut down until the condition had passed. The increase in demand was traced to a leaking tank of ammonia at a fertilizer plant a mile or so up the river.

Detention time in long pipe-lines can be determined easily. A sudden chlorine dosage change will appear many miles down the line as a fairly steep change in residual.

Faulty operations are revealed. When a recorder was installed in a pumping and rechlorination station in another city, it was discovered that the residual dropped to zero each night about seven o'clock, stayed down for about an hour, and then went up to normal. Investigation showed that the night attendant was shutting down the chlorination while he went across the street for supper.

For learning some of the things that go on in the distribution system, a recorder can be used to advantage at a balancing reservoir or a standpipe, or near the end of the system. One elevated tank was found which appeared to execute a spring turnover just like an impounding reservoir.

If desired, the cell and recorder can be separated by any reasonable distance up to several miles, and the cell current run to the recorder over a pair of telephone wires. One such installation has the recorder in a chlorination house at a dam, and the cell in a meter house a mile and a half down the pipe line. It is somewhat of a nuisance to calibrate or work on such a split installation, but in this installation all the personnel are at the dam, and the meter house is visited only once a day.

By use of the amperometric titrator and the amperometric residual recorder, better control of chlorination and more precise results throughout the water plant and distribution system can be achieved.

Nuclear Reactors for Industry and Research

LEGAL ASPECTS

by HERMAN T. VAN MELL*

Section 1801 of the Atomic Energy Act of 1946 establishes basic policy for private operation of nuclear reactors. Section 1804 limits the size of such reactors. Section 1805 retains title to all fissionable material for the Atomic Energy Commission. Section 1810 restricts dissemination of information. Section 1811 limits patents. This is the final installment of this series; the entire series is being made available in book form.

LAW DEPARTMENT of a university or private industry will no doubt deal with the legal aspects of the purchase, installation, and operation of a nuclear reactor. All related legal documentation and procedures will undoubtedly be handled in accordance with the laws of the United States and with applicable state or municipal laws, as well as with the charter or constitution and the by-laws of the university. However, notwithstanding the help of the law department, it is advisable that the faculty and administrators of the university or industry acquaint themselves in a general way with the special legal background of the atomic-energy field.

Basic Policy of Atomic Energy Laws

The basic law is found under Title 42 of the United States Code (the general heading of which is "The Public Health and Welfare"), in Chapter 14 entitled "Development and Control of Atomic Energy."

The present act was passed by Congress on August 1, 1946, and is popularly known as the "Atomic Energy Act of 1946." In this act Congress sought to lay down broad general principles and administrative details looking forward to the widespread use of atomic energy for civilian purposes. For convenience I shall hereafter refer to such section numbers as are found under Title 42 of the United States Code Annotated, the most convenient source for this basic Magna Carta.

Section 1801 is presented in full, because it makes a basic statement about the general scope and purpose within which a privately-owned reactor will function.

1801. *Declaration of policy; purpose of chapter*

(a) Research and experimentation in the field of nuclear chain reaction have attained the stage at which the release of atomic energy on a large scale is practical. The significance of the atomic bomb for military purposes is evident. The effect of the use of atomic energy for civilian purposes upon the social, economic, and political structures of today cannot now be determined. It is a field in which unknown factors are involved. Therefore, any legislation will necessarily be subject to revision from time to time. It is reasonable to anticipate, however, that tapping this new source of energy will cause profound changes in our present way of life. Accordingly, it is declared to be the policy of the people of the United States that, subject at all times to the paramount objective of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace.

(b) It is the purpose of this chapter to effectuate the policies set out in subsection (a) of this section by providing, among others, for the following major programs relating to atomic energy.

(1) A program of assisting and fostering private research and development to encourage maximum scientific progress;

(2) A program for the control of scientific and technical information which will permit the dissemination of such information to encourage scientific progress, and for the sharing on a reciprocal basis of information concerning the practical industrial application of atomic energy as soon as effective and enforceable safeguards against its use for destructive purposes can be devised;

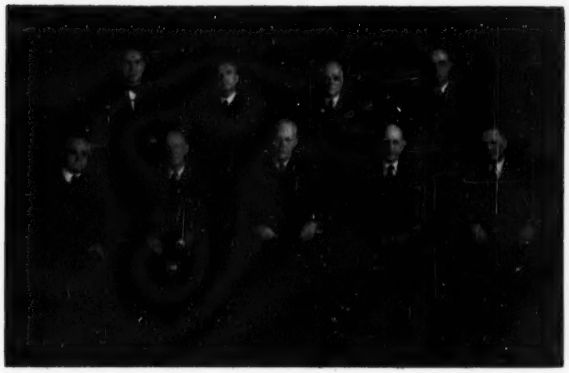
(3) A program of federally conducted research and development to assure the Government of adequate scientific and technical accomplishment;

(4) A program for Government control of the production, ownership, and use of fissionable material to assure the common defense and security and to insure the broadest possible exploitation of the fields; and

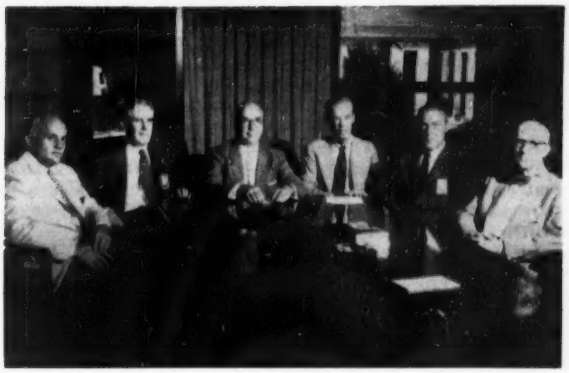
(5) A program of administration which will be consistent with the foregoing policies and with international arrangements made by the United States, and which will enable the Congress to be currently informed so as to take further legislative action as may be appropriate. Aug. 1, 1946, c. 724, 1, 60 Stat. 755.

Section 1802 establishes an Atomic Energy Commission composed of five members appointed by the President with the advice and consent of the Senate. The term of office is five years. Within the Commission there is established a general manager to handle administrative and executive functions. Four divisions (under separate directors) are set up—research, production, engineering, and military application. Nine members, appointed from civilian life by the President, each to hold office for a term of six years, constitute a "General Advisory Committee" to counsel the Commission. The President, by Executive Order No. 9816 (dated September 30, 1946), transferred to the Atomic

*Attorney-at-law and Counsel of the Radiation Counter Laboratories, Inc.



The Supreme Court of the United States, final arbiter of all legal problems. From left to right (sitting): Associate Justices Felix Frankfurter and Hugo Lafayette Black, Chief Justice of the United States Earl Warren, Associate Justices Stanley Forman Reed and William Orville Douglas; back row (standing): Associate Justices Tom Clark, Robert H. Jackson, Harold H. Burton, and Sherman Minton.



Commissioners of the U. S. Atomic Energy Commission and the General Manager. (Left to right) Eugene M. Zuckert, H. D. Smyth, Lewis L. Strauss (Chairman), Thomas E. Murray, Joseph Campbell, and Marion W. Boyer, General Manager.

Energy Commission all properties, materials, facilities, equipment, and the like to clothe the Atomic Energy Commission fully with all necessary properties and powers.

Section 1803 is the basic statement of law under which private reactors will be licensed. It directs the Commission to exercise its power in such a manner as to insure continued research and development, by private or public institutions or persons; to assist in the acquisition of an expanding fund of theoretical and practical knowledge in the fields of nuclear processes; to promote the development of the theory and production of atomic energy, including processes, materials and devices related to such production; the utilization of fissionable and radioactive materials for medical, biological, health, or military purposes; and the utilization of the same materials and the same processes entailed in the production of such materials for all other purposes, including industrial uses. The section also particularly directs the Commission to exercise its powers for the protection of health during research and production activities. This last requirement charges the Commission with duties and gives it full power to make such regulations and to take such action as it deems necessary to protect health, to minimize danger of explosion and other hazards to life and property, and to inspect any work in the field.

Having thus specified the power and duties of the Commission, the Act then proceeds to define terminology and specify limitations in the field. The term "produce" is defined to mean the manufacture, production, or refining of "fissionable material," as distinguished from "source materials," which Section 1805 (b) (1) describes as uranium, thorium, or any other material determined by the Commission, with the President's approval, to be peculiarly essential to the production of fissionable materials. The term "produce" also refers to separation of fissionable materials from other substances in which it may be contained or to produce new fissionable materials.

Reservation of Legal Title to Fissionable Materials

Section 1804 (c) (1) designates the Commission, as agent of the United States, to be exclusive owner of all facilities for the production of fissionable material except those facilities useful in civilian fields, and provides particularly that such facilities shall not have a potential production rate adequate to enable the operator to produce "within a reasonable period of time" a sufficient quantity of fissionable material to produce an atomic bomb and other atomic weapons, it being specifically unlawful for any person to own facilities for production or to produce fissionable material outside of the specific exception. *This provision, then, bears directly on the authority for a university or industrial reactor and obviously places legal limits upon its size and productive capacities.*

It would appear to be implicit in this section of the Act that if through some scientific discovery or invention a university reactor which qualified under the Act suddenly should be made capable of producing the forbidden quantities of fissionable material, it would be wise for the university immediately to notify the Commission of such discovery, suspend production under such new method, and to impose all reasonable temporary security restrictions to prevent the dissemination of such unusual discovery pending written clearance from the Commission or its General Council.

The Commission is authorized to produce or provide for the production of fissionable material, the quantity to be so produced to be determined once each year by the President. This is in addition to fissionable material which may be produced in the conduct of research and development in facilities not owned or required to be owned by the Commission.

Under Section 1804 (d) a university lawfully producing or utilizing fissionable material may expose material of any kind to the radiation incident to the processes of producing or utilizing such material. The Commission is given broad power to license facilities to carry out research and development activities.

Section 1805 relates to the control of materials and defines "fissionable material" as meaning plutonium, uranium enriched in the isotope 235, or any other material which the Commission may determine to be capable of releasing substantial quantities of energy through nuclear chain reaction, or any material artificially enriched by any of the foregoing.

It should be noted that sub-section (a) (2) of Section 1805 specifically provides that all right, title, and interest in or to any fissionable material now or hereafter produced *shall be the property of the Commission.* The Commission may authorize a producer to retain possession of fissionable material, but no person *shall have any title in the same.* This almost unique legal feature should be noted carefully.

Sub-section (3) makes it unlawful to possess or transfer any fissionable material, except as authorized by the Commission, or export from or import into the United States such material except in the defined limitations of the Act. The Commission has power to distribute fissionable material in quantities sufficient to permit the conduct of widespread independent research and development activity, but no applicant will be enabled to obtain an amount sufficient to construct a bomb or other weapons. Note particularly also that the Commission *may recall any distributed fissionable material when an applicant fails to observe safety standards established by the Commission or uses the material in violation of the law.* This power of recall—the Commission at all times retains title in the material—could immediately put an end to research and development activity regardless of the fact that the university had expended great sums of money on facilities. This ever-constant possibility should lead all persons connected with the university program to

insist upon strict adherence to the atomic energy statute and the rules and regulations of the Commission.

The Commission is also given unusually full power over the acquisition of supplies, ores, mineral deposits, and the like, but these powers are not particularly relevant to the purposes of this review.

Sub-section (c) (1) of Section 1805 defines "by-product material" as "any radioactive material (except fissionable material) yielded in or made radioactive by exposure to the radiation incident to the processes of producing or utilizing fissionable material."

Section 1806 deals with military applications of atomic energy.

Licensing Requirements

Section 1807 sets up the licensing requirements hereinafter touched upon. Sub-section (d) of that section provides that if any utilizable energy is produced in the production of fissionable material, such energy may be used by the Commission, transferred to other Government agencies, or sold to public or private utilities under contracts providing for reasonable resale prices. This provision would appear to relate especially to production by the Commission facilities. Such incidental energy by-products may well be produced by a university reactor, and nothing in the Act would apparently prevent its use for incidental energy requirements of a university on an experimental basis, but in such event it would be advisable to have Commission clearance.

Section 1808 deals with international arrangements, and Section 1809 with the property of the Commission itself. This section is of interest to universities only to the extent that the law provides that title to all fissionable material is in the Commission.

Restriction of Dissemination of Information and of Other Matters

Section 1810 is of vital importance since it lays down the policy on control of information which briefly stated is: "It shall be the policy of the Commission to control the dissemination of restricted data in such a manner as to assure the common defense and security."

In applying the policy, the Commission is directed to follow these principles:

1. Until a joint resolution of Congress declares that effective and enforceable international safeguards against the use of atomic energy for destructive purposes have been established, there shall be no exchange of information with other nations regarding use of atomic energy for industrial purposes.

2. Dissemination of scientific and technical information relating to atomic energy should be permitted and encouraged.

3. The Commission may, under certain limitations, make specific arrangements for communication to another nation of restricted data on refining, purification, and subsequent treatment of source of materials; radioactive development; production of fissionable material; and research and development of the foregoing, provided:

(a) That there shall be no communication of restricted data on design and fabrication of atomic weapons;

(b) That no arrangement shall be entered into with any nation threatening the security of the United States;

(c) That restricted data involved shall be limited to the maximum degree consistent with common defense and security and that the Commission considers the recipient nation to have adequate security standards;

(d) That the President on the written recommendation of the National Security Council has made written determination that the arrangement would promote and not endanger the defense and security of the United States;

(e) And that the joint committee on atomic energy of Congress has been fully informed for a period of thirty days during a Congressional session.

Sub-section (b) of Section 1810 defines restricted data as meaning all data concerning the manufacture or utilization of atomic weapons, the production of fissionable material or its use in the production of power, except such data as the Commission from time to time determines may be published without adversely affecting the common defense and security. Stringent penalties are imposed upon communication, transmission, or disclosure of restricted data.

Obviously a university or industry should adopt procedures which will effectively prevent any publication not consistent with these policies, and in case of doubt obtain written clarification from the Commission or its general counsel.

Limitations on Patents

Section 1811 provides that no patent shall be granted after August 1, 1946, for any invention or discovery useful solely in production of fissionable material or its use for a military weapon. The law requires on the other hand that any person who makes an invention or discovery in the field shall file a report with the Commission by the 60th day after completion of such invention or discovery, or the 60th day after the person first discovers or has reason to believe that such invention or discovery is useful in such production or utilization of fissionable material. The university or industry should establish satisfactory supervision and reporting procedure to make sure that timely statutory notice of any such inventions or discoveries is filed. The section further provides that no patent granted after August 1, 1946, shall confer any rights to the extent that the invention or discovery is used in the conduct of research or development activities in the fields described in Section 1803.

Any person (or university or industry, of course) to whom a license has been issued and who makes such an invention or discovery, may use the same in carrying on the activities authorized by his license. (But note the statutory restriction on reactors having the forbidden volume capacity, which probably would qualify this section.) The Commission is authorized to purchase, take or requisition, or by condemnation proceedings seize any invention or discovery which is useful in the production of fissionable material or in the utilization of fissionable material, or atomic energy which is needed for a military weapon or which utilizes or is essential in the utilization of fissionable material or atomic energy. Procedures are set up for compensation, awards, or royalty fees in cases described by the statute.

Section 1812 deals with administrative powers of the Commission. Section 1813 provides for compensation to persons from whom the Commission has acquired property. Section 1814 provides for judicial review and administrative procedure, and Section 1815 establishes a joint committee on atomic energy composed of nine members of the Senate appointed by the President of the Senate, and nine members of the House of Representatives appointed by the Speaker of the House, not more than five members in each case to be members of the same political party. Section 1816 provides penalties for violation of the Act; Section 1817 provides for reports and recommendations to Congress; and Section 1818 restates definitions heretofore described.

Regulations of the AEC

The statute which is the basic law is supplemented, as is the case with governmental commissions or bureaus, by regulations which prescribe in detail the methods by which congressional policy is actually carried out. Applicable parts of the regulations of the Atomic Energy Commission are found in the 1949 edition "Code of Federal Regulations," which is published by the division of the Federal Register of the National Archives and offered for sale by the Superintendent of Documents, United States Government Printing Office, Washington, D. C.

Title 10 of the Code contains the applicable Atomic Energy Commission regulations. No attempt will be made here to summarize the regulations. Complete copies of all of them will normally be available at the offices of the Atomic Energy Commission, P.O. Box 30, Ansonia Station, New York 23, New York.

A word of caution is advisable, particularly in this field where considerations of national security may turn misinterpretation into a serious error. It is specifically provided that no interpretation or explanation of the meaning of the regulations is valid and binding upon the Commission unless issued by its General Counsel, in writing, or by the Commission itself. Not only in the case of doubt may this clarification be requested, but the regulations further provide that petitions may be filed with the Commission for relief in suitable cases from any restrictions which may be imposed by the regulations.

While the Commission has issued a general license freeing a large number of designated instruments and devices from close control, specific licenses are required in several cases. Thus it is necessary to file applications (on forms furnished by the Commission—Form AEC-2) for a license to transfer, deliver, receive possession of, or title to, or export source material. A specific license must also be applied for on Form AEC-17 in order to export facilities for production or to authorize the manufacture, transfer, or acquisition of such facilities for export. Moreover, a specific application for license filed in letter form must be made to obtain authorization for the manufacture, production, transfer or acquisition of any facility capable of producing fissionable material. *This is the license which will be necessary as a condition precedent to installing a nuclear reactor.* These facilities, which come under the head of so-called Class I facilities requiring a specific license, include nuclear reactors, facilities to separate isotopes of uranium, and electro-nuclear machines of the capacity defined in the regulations (cyclotrons and the like).

The actual purchase, installation, and operation of a nuclear reactor involve no unusual provisions of law, and the contract would be handled in the same manner as any other contract or contracts for the purchase of a large scientific facility. It is believed that compliance with the stringent safety standards imposed by the Atomic Energy Commission will, as a rule, constitute only the standard of care which the law normally requires for the protection of the community and of individuals working with a dangerous utility—except for the provision that if any safeguard not covered by the Commission is discovered, a further duty of reasonable care would probably be imposed requiring operators thenceforth to observe such higher standards for protecting themselves against the potential dangers of nuclear reactors. *These provisions, like all the others noted in this analysis, are unlikely to be troublesome to a university or industry that desires to protect individuals and the national welfare.*

APPENDIX

Terminology Used in Radioactivity Measurements

Absorption Coefficient (μ)—A constant used to measure the absorption characteristic of a material for radiation whose absorption follows an exponential law. $I/I_0 = e^{-\mu x}$, where I = intensity of radiation of initial intensity I_0 after passing through thickness x of material. Also, amount of material necessary to attenuate radiation by absorption to 1/e of its initial value.

Avalanche—A process in which one electron produces more than one additional electron by collision.

Background Counting Rate—Rate of counting caused by any agency other than the radiation which it is desired to detect.

Backscattering—Multiple scattering of radioactive particles from radioactive samples mounted on or near matter. This results in additional particles entering a detector.

Coincidence Correction—Since counters have an insensitive time, the observed counting must be corrected to indicate the true counting rate; this correction is called coincidence loss correction.

Cross Section—Cross section of an atom or molecule is the area subtended by that particle for the particular process involved.

Curie—Standard measure of rate of radioactivity decay, equal to 3.71×10^{10} disintegrations per second. It is equivalent to the total rate of emission of alphas from 1 gm. of radium separated from its daughters.

Count—A terminated discharge produced by an ionizing event in a counter tube.

Counting-Rate—Voltage-Characteristic—The counting-rate—voltage-characteristic of a counter tube is the counting rate as a function of operating voltage for a given constant intensity of radiation.

Dead Time—The time interval, after recording a count, during which the counter tube and its circuit are completely insensitive and do not detect other ionizing events (Symbol t_d).

Decay Curve—Graph relating decay rate (counts per minute) of a radioactive sample (as ordinate) versus time (as abscissa).

Efficiency of a Counter Gas—The ratio of particles detected by the counter to particles entering its sensitive region.

Efficiency of a Counter Tube—The probability that a count will take place when the radiation to be detected enters the effective volume of the tube.

Electrometer—Electrostatic instrument or high-impedance-input device for measuring difference in potential. Used in radioactive research to measure change of electric potentials of charged electrodes due to ions produced by radiations.

Electron Volt (ev)—Electron volt and million electron volt (mev) are units of energy. 1 ev = 1.60×10^{-12} erg = 3.82×10^{-20} g.-cal.

Gas Amplification—Ratio of the charge collected to the charge produced by the initial ionizing event.

Geometry Factor—The fraction subtended by the detector of the total solid angle seen by the radioactive source.

Geiger-Muller Counter—A system of electrodes, usually a gas-filled cylinder with concentric wire. The center wire is at a positive potential with respect to the cylinder. Under suitable conditions an ionizing event may produce ions in the gas which in turn create a uniform-amplitude voltage pulse between the electrodes, independent of the size of the initial ionizing event.

Geiger Region—The voltage interval between radiation-counter electrodes in which the charge transferred per isolated count is independent of the charge produced by the initial ionizing event.

Geiger Threshold—The lowest operating voltage between radiation-counter electrodes at which the charged transferred per isolated count is substantially independent of the nature of the initial ionizing event.

Half Life—The time required for the disintegration rate of a radioactive isotope to decrease to one half of its initial rate. Value is a constant characteristic of the isotope.

Half Thickness—Thickness of absorbing material necessary to reduce the intensity of radiation by ½. Usually applied only when absorption obeys the exponential law.

Initial Ionizing Event—An ionizing event which initiates a count.

Integrating Circuit—An electronic circuit which records at any time an average value for the number of events occurring per unit time. Also an electrical circuit which records total number of ions collected in a given time.

Ion—An atom or molecule with an electric charge of either sign.

Ion Chamber—A volume of gas in which a field exists due to a system of charged electrodes. Ions produced in the gas by an ionizing event are collected at these electrodes. The ion current is a measure of the character and intensity of the radiation.

Ionization—The act or result of any process by which a neutral atom or molecule acquires a charge of either sign or by which electrons are liberated.

Ionizing Event—Any event in which an ion is produced.

Linear Amplifier—An electronic amplifier whose gain is constant for a wide variation of amplitude of input signal.

Length of a Plateau—Voltage measured from the Geiger threshold to the voltage at which the slope deviates appreciably from a straight line.

N Unit, for fast neutrons—1 N = 2 to 2.5 rep ≅ 190 ergs/g. tissue.

Normalized Plateau Slope—The normalized plateau slope is the slope of the substantially straight portion of the counting-rate—voltage-characteristic expressed as a ratio of the percent change in counting rate near the midpoint of the plateau to the percentage change in operating voltage.

Non-self-quenching Counter Tube—A counter tube which requires the use of a quenching circuit to terminate the discharge.

Operating Voltage—The operating voltage of a radiation counter tube is the voltage across the tube in the quiescent state.

Overshoot—A counter is said to overshoot if the change in voltage of the anode is greater than the overvoltage.

Overvoltage—The overvoltage of a radiation counter tube is the difference between the operating voltage and the Geiger threshold.

Plateau—The approximately horizontal portion of the counting-rate—voltage-characteristic of a radiation counter tube.

Predissociation—A process by which a complex molecule will lose energy by dissociation before it has had an opportunity to radiate.

Proportional Counter—A radiation counter tube in which the pulse output is proportional to the number of ions produced in the gas by the primary ionizing particle.

Proportional Region—The voltage interval in which the gas amplification is greater than 1 and in which the charge collected is proportional to the charge produced by the initial ionizing event—that is, the region in which the counter tube operates as a proportional counter.

Quenching—The process of terminating the discharge in a counter tube.

Quenching Circuit—A circuit which causes the discharge to cease.

Quenching Vapor—Polyatomic gas used in Geiger-Muller counters to "quench" or extinguish a pulse, thus eliminating need for external quenching resistor or electronic circuit. The quenching action of vapor is due to the fact that it absorbs ultraviolet photons emitted by excited atoms and prevents emission of secondary electrons when ions reach the cathode.

Radiation—Radiation consists of any electromagnetic quantum or any moving electron or nuclear particle, charged or uncharged.

Rate Meter—See integrating circuit.

Recovery Time—The time interval, after recording a count, before the pulses produced by the next ionizing event in the counter are of substantially full size.

Resolving Time—Minimum time interval between counts that can be detected. Resolving time may refer to an electronic circuit, to a mechanical recording device, or to a counter tube.

Region of Limited Proportionality—The region of limited proportionality is the voltage interval below the Geiger threshold in which the gas amplification depends on the number of ions produced by the initial ionizing event and also on the operating voltage.

Relative Plateau Slope—The relative plateau slope is the average slope of the plateau expressed as the percentage change in the counting rate near the midpoint of the plateau per 100 volts change in the operating voltage.

Roentgen (r)—That quantity of radiation which produces one esu of electricity of either sign per $cm.^3$ of air at standard pressure and temperature. 1 r = 1 esu/cc. standard air = 2.083×10^9 ion pairs/cc. standard air = 1.6×10^{12} ion pairs/g. air = 6.77×10^4 mev/cc. standard air = 5.24×10^7 mev/g. air = 83.8 erg/g. air.

Roentgen Equivalent Physical (rep)—If the energy lost by ionization in the tissues is the same as the energy loss for one roentgen of gamma radiation absorbed in air, the dose is spoken of as one roentgen equivalent physical. 1 rep = 83.8 ergs/g. tissue.

Rutherford—10^6 disintegrations per second.

Scaling Circuit, or Scaler—An electronic circuit capable of dividing the incoming pulse rate by a constant factor, so that mechanical methods for recording the pulse may be used.

Self-absorption—Absorption of radiations by the source material itself.

Starting Voltage—Minimum voltage which must be applied to a counter tube to cause it to count, with the particular recording circuit which may be attached (Symbol V_s).

Supply Voltage—Voltage which must be supplied to the counter circuit in a counter tube, and a quenching circuit, if any. (Symbol V_b).

Statistical Time Lag—Time between the occurrence of the primary ionizing event and the occurrence of the count in the counter tube.

Self-quenching Counter Tube—A counter tube in which the discharge ceases due to an internal mechanism within the counter tube.

Spurious Counts—Counts caused by any agency whatever other than radiation.

Voltage Pulse—A change in volts of the central electrode system of a counter tube.

Yield—Ratio of the observed counting rate of a radioactive sample to its disintegration rate.

ANNOUNCEMENT

This chapter concludes the series "Nuclear Reactors for Industry and Research." Within a few months the series will be available in book form. Chapters in the book will be as follows:

I. Nuclear Reactor Types
II. Availability and Selection
III. Nuclear Radiation Measurement
IV. Radiation Protection
V. Reactor Control
VI. Instruments for Experiments
VII. Cost Study
VIII. Legal Aspects

plus an Appendix on Terminology Used in Radioactivity Measurements.

The rapid growth of the field of nuclear-energy production presents many possibilities to all universities and industries. This first book on research reactors for universities and privately-owned industries will be a major contribution to the literature of the field.

Billy Rolly watches Western Scientific Engineer Roberts adjust oscillator in execution of Western's servicing agreement with Ampex. Note mass-production maintenance of test oscillators.

Maintenance of TEST OSCILLATORS

The Wien-bridge-type oscillator circuit is dominant in test oscillators. A complete service and alignment procedure is presented for such test oscillators, including useful modifications for output-level attenuation and indication.

by JAY DOBRIN
Western Scientific Co.

OSCILLATORS produce alternating waveforms of various shapes, the most common being the sine wave, the square wave, and the sawtooth wave. Of these waveforms the sine wave is the most common and useful; applications include circuit testing, bridge energizing, frequency change by heterodyning, frequency measurement by comparison, r-f. carrier, ultrasonic vibrating, and dielectric and induction heating[1].

Oscillators are available with various basic oscillator circuits—tickler coil, Hartley, Colpitts, tuned-plate tuned-grid, ultraudion, electron-coupled, crystal controlled, tuning-fork controlled, magnetostriction, dynatron, transitron, phase shift, Wien bridge, sawtooth generator, multivibrator, Eccles-Jordan, beat frequency, shock excited, Klystron, and magnetron[1].

In recent years the RC Wien bridge and RC phase-shift oscillators (Fig. 1) have become dominant as test oscillators in the range from 0.01 cps. to 10 Mc. because of numerous advantages—(1) with all tubes operating Class A, distortion can be kept low with inexpensive components, (2) with a simple nonlinear resistive element such as a Type 6S6 lamp, the output level can be maintained within a fraction of one db over a frequency range of 10,000 to 1, (3) as there are no inductors, frequency calibration is relatively easy, and optimum results can be obtained at any frequency within its range, irrespective of "L to C ratio" or "Q of tank circuit," and (4) the frequency is proportional to C, instead of $\sqrt{C}$, thus permitting wide coverage of frequency within one instrument.

A circuit of a typical oscillator of the Wien-bridge type is shown in Fig. 2. The positive feedback (which develops oscillation) is from the plate of V2 through the 40-uf. capacitor through R1-C1 to the grid of V1. At the same time, a path of negative feedback exists from the plate of V2, through the 40-uf. capacitor, to the cathode of V1 through R4. Alternating current through V1 must flow through R3, the regulating lamp. If the output level tends to increase, the feedback voltage at R3 would increase; this would increase the resistance of the lamp, which would increase the negative feedback, thus reducing and stabilizing the output level. The frequency of oscillation is $1/\sqrt{R_1 R_2 C_1 C_2}$.

Trouble Symptoms

Oscillator troubles show up in failure of the instrument to provide the following: (1) Correct output voltage. (2) Correct frequency (dial) calibration. As resistors age, as capacitor bearings wear, and as tubes are renewed, the dial reading will no longer indicate the true output frequency. (3) Constant output level as frequency is varied. The dial calibration and the level of output are closely interrelated. (4) Freedom from distortion in output. Poor power factor in electrolytic capacitors introduces phase

shift into the beta or feedback network, causing distortion. Weak rectifier tubes in the instrument's power supply also cause improper ratios of positive-to-negative feedback, resulting in output distortion. (5) Freedom from noise and hum. "Scratchy" gain controls, weak or partially shorted tubes, and bad filter capacitors contribute to spurious content in the output. (6) Oscillator stability. Aging of components and shifting of resistor values can cause excessive negative feedback and oscillator instability, particularly at lower frequencies. (7) Correct output impedance. Many oscillators have a large electrolytic capacitor in the output circuit and an output amplifier with large negative feedback to provide low output-impedance. Other instruments obtain low output-impedance by use of a cathode-follower circuit in the last stage. In either, aging and lack of maintenance prevent the instrument from having correct output impedance.

Routine Service Procedure

Preventive maintenance guide is given in step-by-step form; it should be followed in sequence. Oscillators used

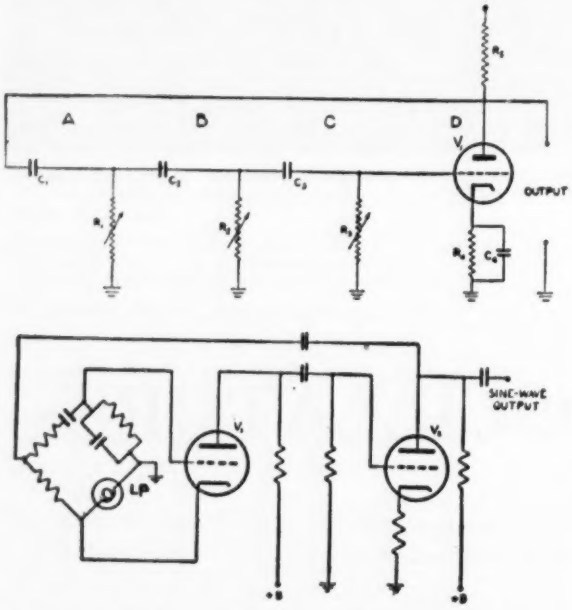


Fig. 1. Top, basic RC phase-shift oscillator; each RC section causes 60-degree phase shift at one frequency to produce the required 180-degree shift necessary for sustained oscillation at that frequency. Bottom, basic Wien-bridge circuit. As two tubes are used, feedback signal from plate of V2 is of proper polarity to sustain oscillation; the frequency-selective bridge determines the operating frequency.

for more than eight hours daily should be serviced quarterly.

Remember that dangerous voltages exist in all instruments; discharge capacitors and ground all circuits before touching components.

Step I. Renewal of Vacuum Tubes

Vacuum tubes are renewed first to permit adequate warm-up of the tubes and also because tube renewal necessitates circuit adjustment.

A. Check all tubes and renew tubes falling to 60 percent rated mutual conductance.

B. Check all rectifier tubes by some approved emission technique; renew those falling to "questionable" emission. A practical emission check may be accomplished by testing the tube conventionally; then reducing the applied filament voltage by 10 percent. If the indicator on the tube tester falls as much as 25 percent, the rectifier should be discarded.

Step II. Physical Check

A. Inspect top and bottom for loose or unsoldered connections. Even instruments in use for several years have been found to have connections which were never soldered at the factory.

B. Look for common signs of overheating of components —wax, tar, electrolyte deposit on bottom pan, flaking of paint from chokes or transformer cases, discolored resistors, smoky ceramic capacitors.

C. Look for signs of misuse. Renew broken binding posts. Remove pencil or ink calibration marks from frequency dial. Check and renew line cord if frayed. Replace pilot lamp if necessary. Clean chassis, cover, and bottom pan with dry cloth.

D. Tighten regulator lamp in socket.

E. Lubricate as follows: (1) Volume control, gain control, or attenuator with an approved control anti-noise preparation. (2) Variable-capacitor bearings with one drop of spindle oil. (3) Variable-capacitor phosphor-bronze contact fingers with anti-oxidant lubricating paste. (4) Belts,

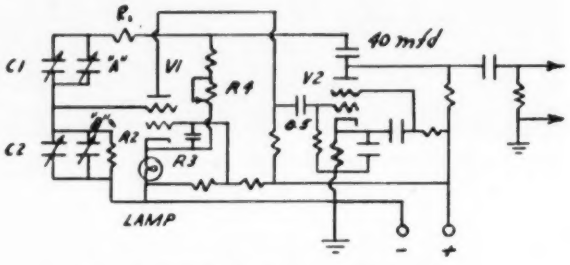


Fig. 2. Typical Wien-bridge oscillator circuit.

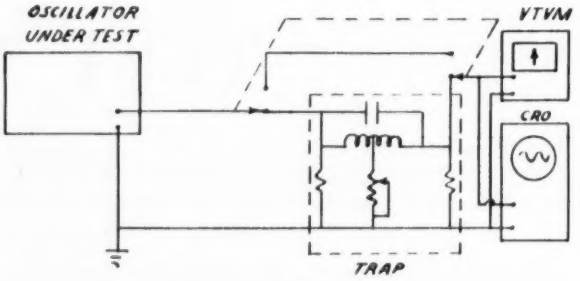


Fig. 3. Setup for adjusting feedback circuit.

pulleys, gears, shafts in accordance with instrument instruction manual.

F. Check fuse for rating.

Step III. Check of Power Supply

As all circuits depend on proper plate potentials, and as many instruments use a regulated supply, the adjustment of power supply precedes alignment of the oscillator.

A. By reference to the instruction book, adjust the direct current at the regulator output to its proper value.

B. If the supply is not regulated, measure the direct current at the supply output and check it against the manufacturer's instruction manual, bearing in mind that his measurements were probably made with 117-volt line voltage.

C. Ripple content can be measured with an oscilloscope or a-c. vacuum-tube voltmeter. This step is optional and is not recommended for regular routine maintenance where numerous instruments are involved because the incidence of troubles will not justify the extra cost in time consumed.

Step IV. Adjustment of Feedback Circuit

The feedback circuit is adjusted to provide proper output with minimum distortion. This is done prior to major dial and level adjustment (Step V) because this adjustment affects the frequency of oscillation.

A. Adjust to 1.0 volt at 500 cps.

B. Connect apparatus as in Fig. 3. (If distortion is eliminated at the lower frequencies, the higher frequencies usually will be distortion free. This is because capacitors in the feedback circuits tend to have the greatest reactance and greatest phase shift at the lower frequencies.)

C. Insert trap and tune the oscillator to the trap frequency. Total harmonic distortion should be as specified by the manufacturer. (Most suppliers of oscillators of this type advertise total harmonic distortion contents of 1 percent. This is a voltage ratio of −40 db; however, many oscillators will contain distortion of only −46 db, with an occasional unit having only −50 db for the rated output.) To adjust to proper distortion content, adjust R4 (Fig. 2). Decreasing R4 will increase the negative feedback, thus

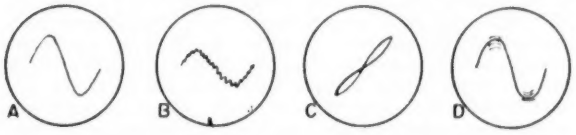


Fig. 4 A, normal sine-wave output; harmonic distortion less than 5 percent is not discernable. B, normal harmonic distortion observed at output of trap. C, phase-shift Lissajous pattern resulting from distortion in source oscillator; distortionless oscillator produces straight line. D, 60-cycle modulation of oscillator output resulting from cathode-to-filament short in V2.

reducing the output level and simultaneously reducing the distortion.

D. Remove trap and re-establish the 1.0-volt reference level. Repeat the measurement of distortion. Do not attempt to exceed the manufacturer's rating for total distortion content until you have completed the next step.

E. Remove trap and terminating resistor. Adjust oscillator to maximum output. Measure level. This voltage should be correlated with the manufacturer's specification for the maximum output of the instrument. Certain units (such as the Hewlett Packard "Model 200C") will produce about 11 or 12 volts under this condition. Some suppliers specify milliwatts of power into certain loads. These conditions must be simulated, or the open-circuit maximum voltage must be calculated from the known internal generator-impedance. Excessive reduction of distortion as in paragraph C will result in inability of the instrument to produce its maximum output.

F. If the output is adequate or above the specified maximum, distortion can be reduced somewhat further; however, an added word of warning: Often, attempts to reduce distortion beyond the manufacturer's specification can cause the oscillator to be unstable, to "wink" when switching between bands, and to "hunt" in level when adjusting the frequency.

G. If an annulling trap for distortion measurement is not available, adequate adjustment can be made on the basis of maximum unterminated output alone—if the engineer knows just what maximum output level will normally accompany the tolerable minimum of distortion.

H. If the unit will not adjust to −40-db total harmonic distortion with the adjustment of the potentiometer provided, it will be necessary to: (1) Renew lamp. Try several from stock; a new one can cause a worse condition than the original. (2) Replace fixed resistor in series with potentiometer. A lower resistance will increase feedback, reduce distortion. (3) Make sure that spurious signal in the output is harmonic distortion and not hum or noise (Fig. 4). In a normal output containing only harmonic distortion, the peaks occur at two and three times the oscillator frequency. If peaks occur at 60 or 120 cps., or consist of "grass," the trouble is hum or noise, not distortion. In such event, try renewal of V2, which sometimes develops a short circuit from cathode to filament. (4) Check the large electrolytic capacitors in the beta networks. (Caution: These units are not at ground potential.) (5) Repeat Step II to locate a noisy resistor, faulty capacitor, etc.

Step V. Alignment

The constancy of output level and the establishment of dial calibration are interdependent. All adjustments will be described from observations of what is termed "delta-E" (the difference in level from the high end of the band to the low end, abbreviated dE.)

A. Precautions to be observed: (1) Do not attempt alignment with top cover removed. (2) On some models, alignment must be made with bottom pan also in place, through holes provided for insertion of the alignment tool. (3) Use

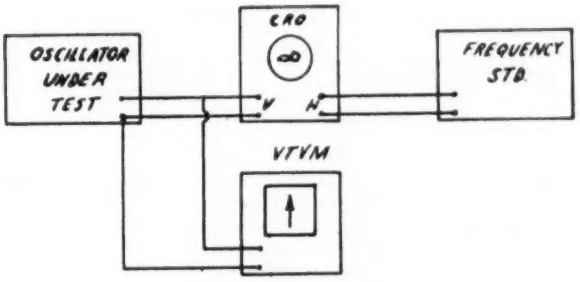


Fig. 5. Setup for alignment.

a plastic or insulated aligning tool. (4) All adjustments are made at the high-frequency end of the band; under no circumstance should a trimmer be turned while the dial rests at other than the high end of the band.

B. Set up apparatus as in Fig. 5. If a frequency standard is not available, an emergency calibration can be made against a 60-cycle signal by using the 3:1 pattern at 180 cps. and the 1:3 pattern at 20 cps. Most telephone-company offices offer a 1000-cycle tone over subscriber lines, which is accurate for this purpose. (A compact crystal-controlled frequency standard with provision for continuous check against WWV and accurate to 0.0002 percent per degree of temperature can be assembled for about $150.00 in parts.) Refer to Fig. 2. Trimmers "A" and "B" control the alignment in accordance with instructions listed below.

C. Definitions: "dE" signifies difference in level between high end and low end of band. "Dial reads high" means that to obtain an output known to be 2000 cps., the dial will be set for 2100 cps., for example. "Dial reads low" means that to obtain an output known to be 2000 cps., the dial will be set to 1900 cps., for example. "Output level low" means that the output level, which is observed at the high-frequency end of the band, is lower than the level observed at the low-frequency end of the band. (NOTE: Reference is always made to the alignment situation observed at the high-frequency end of the band, as that is where all adjustments must be accomplished.)

D. Instructions for use of alignment chart:

(1) Set up equipment as in Fig. 5. Set oscillator band switch to the band which contains 1000 cps. Set oscillator level to about 0.75 volt into some convenient load. Swing dial from high-frequency end to low-frequency end. While observing the output level and the Lissajous pattern at the high-frequency end, analyze the alignment condition. The alignment condition will fall into one of the eight catagories listed on the alignment chart.

(2) After the alignment condition has been analyzed, and its appropriate category located on the chart, set the dial to the highest even-order numerical point of calibration. (For example, with a Hewlett-Packard "Model 200C," place the dial at 200 on the x10 scale, or 2000 cps.) Proceed with the application of the alignment chart. The dial will be in calibration when the Lissajous pattern stops on 2:1 with a standard frequency of 1000 cps., while the dial is set precisely at 200 "on the line." The level of output is said to be "OK" when dE is less than 0.25 db from 2000 to 200 cps.

(3) Exceptions to troubles which can normally be corrected by use of the alignment chart are covered in following paragraph E.

(4) Instructions in the alignment chart are worked out carefully. Alignment can be accomplished rapidly if the proper direction of adjustment is observed carefully.

Alignment troubles not correctable by use of alignment chart:

1. If, after careful alignment as outlined in the chart, the high-frequency end of the band can be aligned perfectly

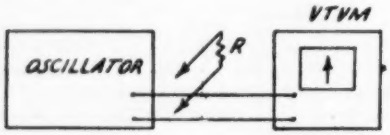


Fig. 6. Setup for checking output impedance.

and all dE can be eliminated—BUT the low-frequency end of the band will not fall into alignment, the trouble can be one or both of the following: (a) Dial has become loosened on its shaft, and full capacity point does not coincide with mark or dot on dial scale. To restore to original position, set variable capacitor to full capacity, and after loosening dial plate, set dial to the dot or mark which describes the full-capacity point. This is not the lowest numerical mark on the scale, but a small dot placed on the dial for this purpose. (b) Capacitor plates require bending. The outside plate on each rotor section of the variable capacitor is divided to permit slight bending of individual segments of each section for calibration at the low end and at the middle of the scale. If the dial reads high, bend the rotor-plate segments away from the stator plates, and vice-versa. Caution must be observed to prevent shorting or creating an intermittently shorting condition.

2. After completion of alignment procedure on the scale containing 1000 cps., check all other scales for calibration and level at several points. The manufacturer specifies a tolerance for accuracy of alignment of scale calibration and of constant level. Each scale or band should meet these specifications.

ALIGNMENT CHART

Category — *Analysis*	*Adjust Trimmer A*	*Adjust Trimmer B*
1. Dial reads high. Output level low.	(1) Raise level by ½ dE.	(2) Turn to raise level, which will pull frequency into calibration.
2. Dial reads high. Output level high.	(1) Reduce level by ½ dE.	(2) Turn to drop level, which will pull frequency into calibration.
3. Dial reads high. Output level ok.	(1) Lower level by 0.5 db for every division that dial is off calibration.	(2) Turn to raise level back to reference, which will pull frequency into calibration.
4. Dial reads low. Output level low.	(2) Raise level to overshoot level reading by an amount equal to about 0.3 db for every division dial is out of calibration.	(1) Adjust to maximum level reading. (3) Turn to reduce level, which will pull output frequency into calibration.
5. Dial reads low. Output level high.	(2) Reduce level which will pull frequency into calibration.	(1) Reduce level by about ½ dE.
6. Dial reads low. Output level ok.	(1) Raise level by about 0.5 db per division that dial is out of calibration. (3) If not correct after adjustment (2), then analyze new condition and proceed again.	(2) Lower level which will pull frequency into calibration.
7. Dial reads OK. Output level high.	(1) Lower level by ½ dE.	(2) Reduce level, which will pull frequency into calibration.
8. Dial reads OK. Output level low.	(1) Raise level by ½ dE.	(2) Raise level, which will pull frequency into calibration.

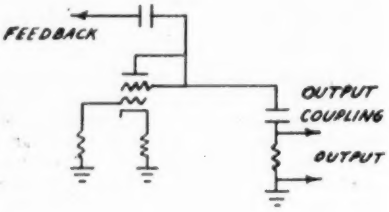


Fig. 7. Typical output circuit using coupling capacitor.

a. If one scale is out of calibration, it will be necessary to compensate this one scale by adjustment of R2 (Fig. 2) for that band. It is usually found that R2 for each band consists of two resistors in series, mounted on the band-selector-switch body. To raise the output frequency for a given setting of the variable capacitor, R2 should be decreased in value. Only the best-grade carbon or deposited-carbon-film resistors should be used for trimming calibration. Here again, calibration should be accomplished on the high-frequency end of the band.

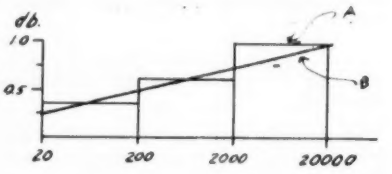


Fig. 8 Typical variations in level adjustment across bands.

b. Ideally, R1 should equal R2 (Fig. 2). Therefore, if an accurate megohm meter is available, R1 and R2 (for the band which is out of calibration) should be compared. They should be replaced with resistors of equal value which, in combination, move the calibration in desired direction.

c. In practice, oscillators are seldom found in such bad alignment as to require this complete procedure; small changes in the R2 trimmer usually will accomplish the desired result.

Step VI. Check of Output Impedance

After completion of the alignment procedure, the output circuit should be checked for proper output impedance.

A. The recommended method of measurement is the so-called "six-db-drop method." Apparatus is set up as in Fig. 6.

B. Set oscillator output to "0 dbm" point on VTVM, at 1000 cps. with no load. Attach potentiometer or decade resistance box (R). Adjust resistance until VTVM reads −6 dbm. Value of resistor or decade box now equals internal (output) impedance of oscillator.

C. If output circuit is as in Fig. 7, excessively high output-impedance can be caused by defective output coupling capacitor. Also, if the feedback capacitor is defective, the output impedance will be excessive, and distortion and excessive maximum output voltages will appear.

D. If a cathode follower is employed in the output, high impedances can be caused by a defective tube or component in this circuit. Normal trouble-shooting procedures and d-c. voltage measurements can disclose the cause of such troubles.

Step VII. Run-in and Fincl Check

A. Secure top and bottom covers.

B. Run-in instrument for one hour.

C. Check calibration and level across any one band. Look at wave shape and check maximum output level. Check operation on each band and across each band.

D. Restore to service. See that data is current with respect to use-location of the instrument in the plant.

E. Post service on data card.

Miscellaneous Notes

A. It is possible to make an output level adjustment which provides perfect level across one band, but which causes a slight increase of level when switching to the same frequency on the next higher band. Or, it is possible to obtain an output level adjustment in which the level at the high-frequency end of one band is identical to the level at the low-frequency end of the next higher band, but rises slightly across each band. However, it is always a compromise as to which adjustment is preferred, as both conditions can seldom be met. These conditions are shown in Fig. 8.

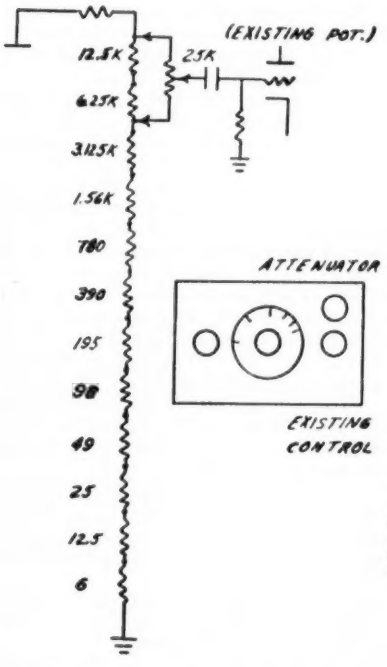


Fig. 9. Level-adjustment modification providing 6-db steps plus vernier.

B. Frequency drift with power-line fluctuation must be expected in instruments which have no regulated power supply. At higher frequencies this is accentuated.

C. Analysis of several hundred oscillators with a selective wave analyzer have indicated that the average output contains:

Second harmonics:	0.2 to 0.3 percent
Third harmonics:	0.3 to 0.35 percent
Other measureable harmonics:	0.1 percent
Noise:	0.05 percent
60 cps. and 120 cps:	0.05 percent

D. The lamps used in most oscillators have a thermal lag at the lower frequencies. These instruments "hunt" in level when a change is made in frequency, particularly at the lower frequencies. This can occur although all adjustments are correct. However, the output should stabilize within a few cycles after establishing a frequency of oscillation.

E. With the circuit shown in Fig. 7, some direct current will be found in the output, which will jump or bounce with changes in power-line voltage. This is normal, and if the instrument is installed on the same service with a heavy machine which has a high, pulsating power demand, such as a spot welder, even line-voltage stabilizers may not remove this component.

F. Fig. 9 shows a useful modification which permits adjustment of output levels to within 0.1 db. It provides (1) a "vernier" on the gain control, and (2) steps of level adjustment of 6 db per step, from maximum to −66 db. The variable potentiometer control has 12-db total variation, providing a continuously variable output with 100-percent overlap for all settings of the step attenuator, and without disturbing any of the impedances or other characteristics of the instrument. It has no effect on the output circuit, being installed between the oscillator and amplifier portion of the instrument. There is ample space in all but the latest miniaturized equipments for this modification.

G. Fig. 10 shows an essentially flat-response output indicator which terminates the oscillator in 600 ohms and displays negligible frequency characteristic to over a mega-

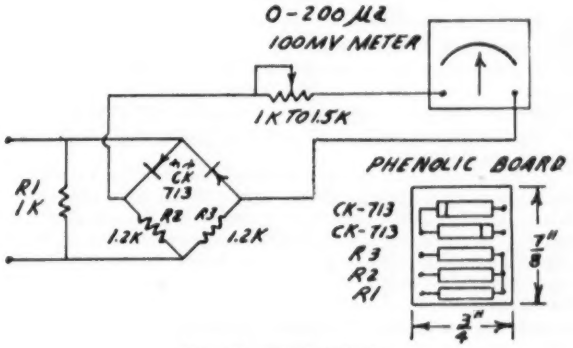


Fig. 10. Output indicator.

cycle. It may easily be calibrated in db. With the constants shown, it will read about plus 3 dbm for full scale and minus 2 dbm at half scale. The scale distribution will be logarithmic, and may be calculated from the linear voltage distribution of the existing indicator scale.

Apparatus Required

The following should be assembled into a test station or console for the express use of adjustment of oscillators, if fifty or more instruments are to be handled on a service schedule. With the proper setup and personnel, complete service as outlined will entail about 1.22 man hours per service.

1. Oscilloscope, sensitivity of 50 mv./in. recommended.
2. Vacuum-tube voltmeter, a.c., 0.001-volt full scale sensitivity.
3. Frequency standard.
4. Annulling trap for 500 cps.
5. Resistance decade box, or potentiometer.
6. Tube tester.

Optional Apparatus

1. Variable-frequency wave analyzer.
2. Frequency counter.

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Control of Chemical Processes

This tenth installment presents electronic and electric controllers of American, British, and German manufacture—controllers which use electric or electronic means to generate the control actions.

by A. J. YOUNG
Imperial Chemical Industries, Ltd.

Electronic and Electrical Controllers

ELECTRONIC AND ELECTRIC CONTROLLERS are those which use electronic or electric techniques for generating the proportional, integral, and derivative actions. The input or output signals can be pneumatic simply by using an electric-to-pneumatic converter; most of the controllers have such converters as both input and output accessories.

In the chemical industries, some of the process variables to be controlled (temperature, conductivity, pH, etc.) are measured electrically and the outputs of the measuring systems can become, often without conversion, the inputs to the controllers. Other process variables (pressure, flow-rate, etc.) are most often measured mechanically; and the displacement or deflection of a moving part is converted into an electrical change—a change of voltage, current, frequency, or phase—which becomes the input to the controller.

For safety reasons the power level of an electrical input to a controller in the chemical industries is extremely low, whence the necessity for high amplification in order to operate valves, etc.

Evershed & Vignolles (British)

Electric Controller

This controller, Fig. 10-1, is based on a moving-coil-photoelectric system. It is designed to operate on an electric input signal varying from 0 to 30 ma. for full range of the measuring unit. Changes in the controlled condition are detected by orthodox detecting units and transmitted as a current in the 0-10-ma. range to the control unit and to any indicator or recorder required, by an electric transmitter based on a force-balance system.

Transmitter T gives an input current I_m which is proportional to the magnitude of the physical condition measured by detecting element DE. The input current is passed through one coil of a double-coil moving-coil instrument (enclosed in dotted rectangle in the figure). The moving coil system carries a shutter (s), so that deflection of the system causes more light from source L to fall on one or other of photocells P_1 and P_2.

The unbalanced current resulting from such a deflection is amplified by amplifier A and fed back to the second coil of the moving-coil system as current I_0, to restore the balance. Therefore I_0 is maintained proportional to I_m. It is also passed through regulating unit R.U. and a control action is obtained such that the output of the controller (i.e. I_0) will vary from 0 to 100 percent when the input from the detecting element varies over the full range, corresponding to 100 percent variation in I_m.

By placing a differential shunt R_4, as shown, across the two coils, the ratio $I_m:I_0$ can be varied. The proportional band width is therefore controlled by the setting of R_4; it can be varied from 2 to 600 percent.

Integral action is generated by:

(a) Obtaining a current proportional to deviation θ.

(b) Allowing this current to charge a large capacitor so that the potential of the capacitor at any time (t) after a deviation has occurred is $K'_0\int\theta dt$.

(c) Applying this potential to the grid of a pentode, which then gives a proportional current output $I_1 = K_0\int\theta dt$;

(d) Feeding this current through the coil of the proportioning system which carries I_m.

The output of the controller will then be given by $I_o \propto I_m + I_1$ and so contains the integral action contribution.

The current proportional to θ, required by (a) above, is generated as follows. Transmitter T', similar to T, gives a current I_C proportional to the desired value set. I_C is passed through one coil of a photoelectric system similar to that shown in the dotted rectangle, used to generate proportional action; I_m is passed through the other coil. This system is shown schematically by unit X in the diagram. The output of X is a current proportional to $I_m - I_C$, i.e. to θ.

The values of K'_0 (and K_0) are varied by changing the current in the bulb used to illuminate the photocells in the unit X. The resistor used to control the current is graduated in minutes (integral action time).

Derivative action is generated by allowing the potential difference across resistance R_3, which carries I_m, to charge a capacitance through resistance R_5. The potential across R_5 will therefore, as mentioned previously, be proportional to dI_m/dt or $K'_2\ (d\theta/dt)$.

This potential difference produced by derivative action unit D is added to that produced by integral action unit I and the total applied to the grid of pentode A'.

The current output of the pentode $(I_1 + I_2)$ will thus be $K_0\int\theta.dt + K_2(d\theta/dt)$, and is fed with I_m through the proportional action unit as before.

The total ouptut of the controller (I_0) is now given by $I_o \propto K_1\ (I_m + K_0)\theta dt + K_2 d\theta/dt)$.

Derivative action time is adjusted by altering the value of R_5, which is a variable resistor calibrated in minutes (derivative action time).

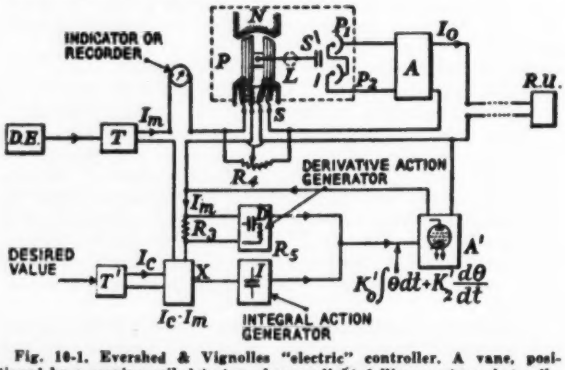

Fig. 10-1. Evershed & Vignolles "electric" controller. A vane, positioned by a moving-coil detector, changes light falling on two photocells. Photocell-output differential is error signal. Derivative and integral actions are generated by RC networks in the input to the amplifier.

CORRECTION—In the preceding installment on pneumatic controllers, references to the "Model 88" controller of Moore Products Company (page 446, March issue) were in error. The correct model number is "Model 55."

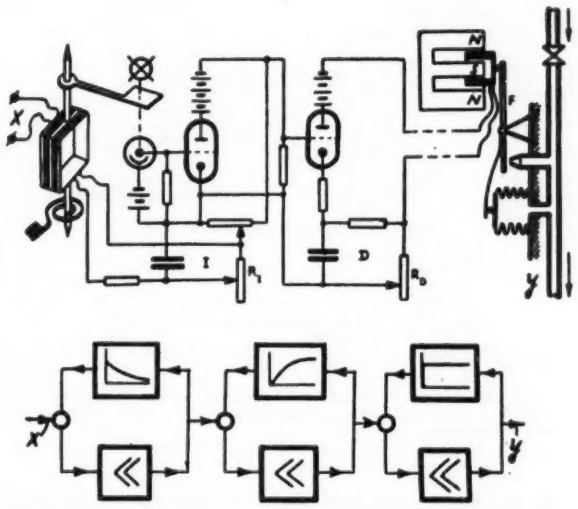

Fig. 10-2. Hartmann & Braun "Regelux" controller. Photoelectric cell develops error signal. Derivative and integral actions are generated by RC networks in the cathode circuits of the two direct-coupled amplifier stages. Bottom illustration shows functional actions.

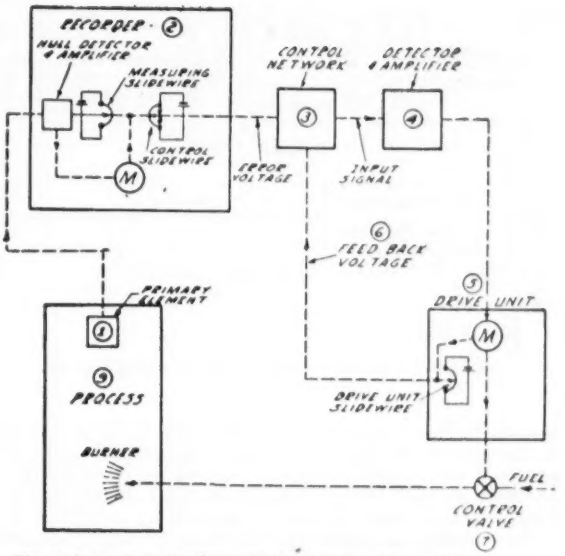

Fig. 10-3. Leeds & Northrup "Series 50" electric controller.

It should be noted that there is no interaction between the integral and derivative actions and therefore the settings on the dials are actual action times.

Hartmann & Braun (German)

"Regelux" Controller

As shown in Fig. 10-2, input signal x from the measuring unit is fed to one coil of a moving-coil system which is balanced by feedback from the photocell amplifier system to its second coil. Resistance-capacitance system I in the feedback circuit produces an output proportional to the rate of change of signal from the amplifier. This is fed back negatively and so produces the integral action. The integral action time is adjusted on resistor R_I.

The output from this stage is fed to the second stage, in which derivative action is added by the resistance capacitance system D. Derivative action time is adjusted on resistor R_D.

The electrical output of the controller, containing the proportional, integral, and derivative action contributions, positions a coil in the field of the permanent magnet (N S N) and so positions flapper F relative to nozzle N. The *final* output is therefore pneumatic.

The circuit arrangement is such that there will be interaction. The interaction factor is the same as that of the Bristol pneumatic controller described previously, namely $[1 + (r/s)]$. The most powerful derivative action will therefore be obtained when $r = s$ and the interaction factor will then be 2.

Leeds & Northrup

"Series 50" Electric Controller

This controller is essentially two potentiometer-type automatic null-balance units in parallel. The components of the complete system are shown in Fig. 10-3; the right-hand units of Fig. 10-3 are shown in greater detail in Fig. 10-4.

The "control slidewire" in the standard Leeds & Northrup potentiometer recorder (shown at the left in Figs. 10-3 and 10-4) follows movements of the "measuring slidewire." Any unbalance in this unit produces voltage e_1.

The second potentiometer unit positions the "valve slidewire" whenever voltage e_2 differs from e_1. The voltage e_2 is developed across the resistor shown in series with the valve-slidewire contact. (This resistor is R_1, but is not so labeled in the figure.) The "drive unit" motor positions the valve slidewire so that $e_2 - e_1$ is reduced to zero. Proportional action is thus obtained.

To obtain *integral (reset) action*, capacitor C_1 is added in series with R_1 and the valve-slidewire contact, as shown in Fig. 10-4. The drive unit will still maintain $e_1 = e_2$, but a potential e_3 will exist across C_1. If the current in R_I at any time is I, then $I R_I = e_3$, and the rate as which e_3 is changing is proportional to I. But $(e_2 + e_3)$ is the total output from the slidewire bridge, so that if $(e_1 - e_2)$ is maintained at zero, the valve slidewire contact must move continuously (to produce the additional voltage e_3) at a rate proportional to I, i.e. to e_1. By definition, integral action results.

To obtain *derivative (rate) action*, the network R_2—C_2 is added as shown in Fig. 10-4. This network attenuates

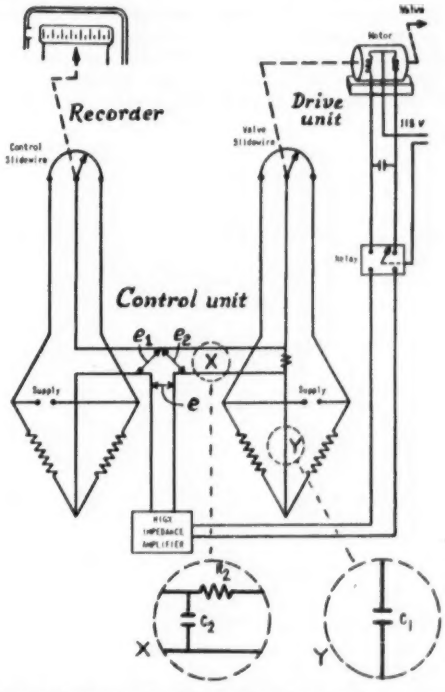

Fig 10-4. Control network of L&N controller operates on error signal representing difference between outputs of recorder potentiometer and drive-unit potentiometer. Resistor R1 is the unmarked resistor in series with the valve-slidewire contact, across which e2 is developed. X is derivative-action network. Y is integral-action network.

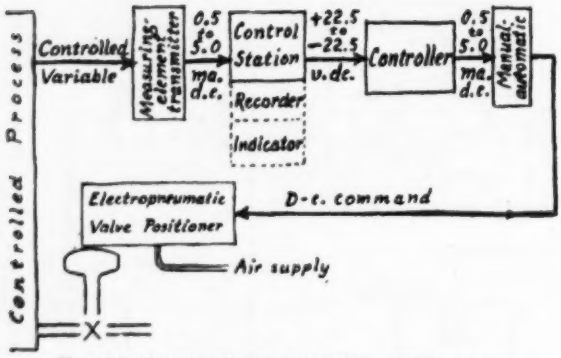

Fig. 10-5. "American" electronic process control system.

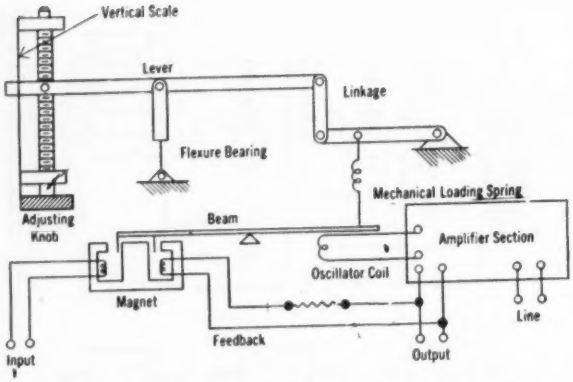

Fig 10-6. Set point section of "American" system. "Microsen" force-balance unit develops error signal, which is delivered to controller after preamplification.

the rebalancing voltage (e_2) in proportion to the frequency of the voltage. The faster the signal, the greater the attenuation of the rebalancing signal, and the greater the signal to the drive unit. This, by definition, is derivative action. Control action times are set by adjustment of R_1 and R_2.

This method of generating the integral and derivative actions gives interaction between them. The interaction factor can be shown to be $[1 + \alpha\ (r/s)]$, where $\alpha = [(C_1 + C_2)/C]$, where C_1 and C_2 are the integral and derivative action capacities and C is a constant for the controller.

Manning, Maxwell & Moore

"American" Electronic Controller

This system comprises primary and final elements of customary sizes, and miniature units (recorder, indicator, controller, and manual positioner) for panel mounting. The components are shown in Fig. 10-5.

A distinctive feature is use of d-c. signal throughout, making the system insensitive to induced a-c. pickup and easily incorporated into auxiliary computer circuits if desired.

Fig. 10-6 shows the electromechanical "Set Point Section" of the control station, which selects the operating point, operates as a preamplifier, and delivers the signal to the controller. The input to the set point section is 0.5 to 5.0 d-c. milliamperes, at 70 ohms internal resistance (the output of all transmitters used with the controller); the output is plus 22½ to minus 22½ volts maximum, d.c. The set-point unit uses the maker's "Microsen" force-balance unit, comprising differential electro-magnetic coil, balance beam, and oscillator coil. Motion of beam detunes oscillator, causing feedback signal from amplifier to coil to restore balance of beam and oscillator frequency. Amplifier output goes to controller.

The "Type 163" controller is shown in Fig. 10-7. The input is plus 22½ to minus 22½ volts d.c. from the control station; the output is 0.5 to 5.0 ma. d.c. to the valve positioner via the manual-automatic station. Each triangular block represents a high-gain vacuum-tube amplifier.

Derivative (rate) action is obtained by delaying the degenerative feedback signal to the first amplifier. As the S1-C1 network is frequency sensitive, fast signals produce less negative feedback, resulting in higher amplifier gain. When derivative action is not desired, the input can be connected directly to the input to the second amplifier. Rate action is adjustable in steps between 0.01 to 1 minute, or 0.1 to 10 minutes.

Proportional action is obtained by varying the negative-feedback signal to the second amplifier through capacitor C21. The output current to the valve positioner develops

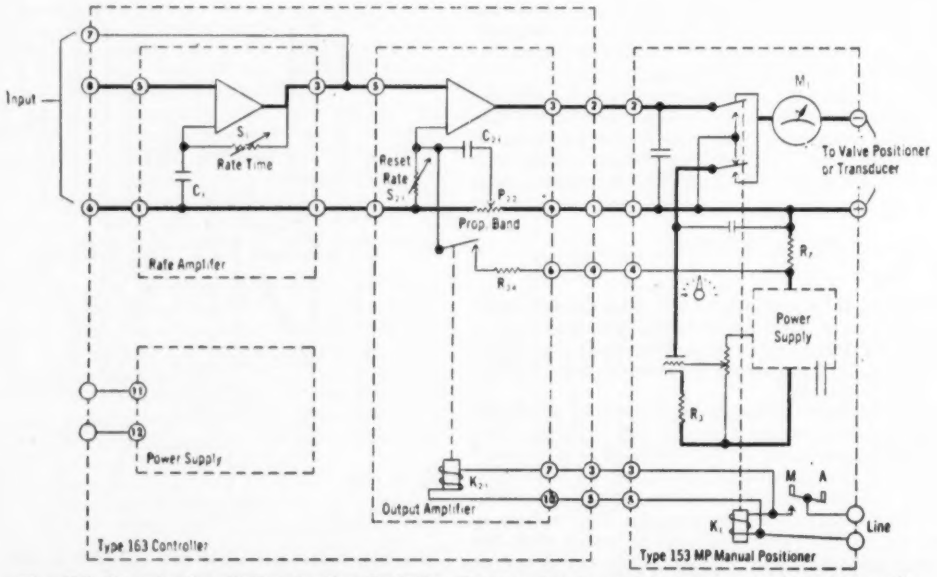

Fig 10-7. "American" controller circuitry. Derivative RC network is in negative-feedback circuit to first amplifier. Integral RC network is in second-amplifier stage. Manual positioner causes controller to follow manual setting, making "bumpless" transfer possible.

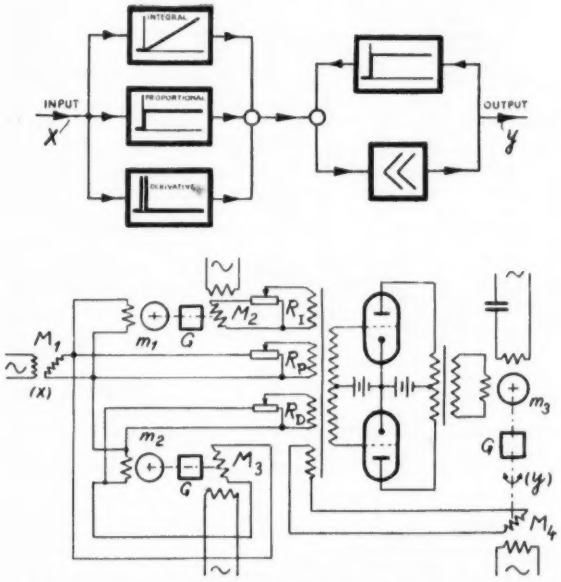

Fig. 10-8. Schoppe & Faeser controller uses angular-position transmitters (magslips) and a mixing transformer to add the control actions.

a proportional signal across resistor P22. A portion of this proportional signal is fed back degeneratively to the second amplifier through C21, reducing its gain. Hence P22 controls the gain of the proportional-band amplifier. The band is adjustable from 1 to 200 percent.

Integral (reset) action results when resistor S21 is inserted in the circuit. This resistor refers the operating potential of the second amplifier to a fixed reference point. If the operating point drifts away from the control point, owing to load change, a steady input signal appears which operates through the full high gain of the second amplifier to restore the variable to the control point. For more rapid signals the gain of the second amplifier is reduced owing to the feedback signal through C21. Reset rate is adjustable from 1 to 100, or 0.1 to 10 repeats per minute.

Fig. 10-7 also shows the way in which the controller and manual positioner are interconnected to effect "bumpless" changeover from manual to automatic operation. This is done by having the controller output automatically follow the output of the manual positioner—the signal developed across R7 in the manual positioner is connected through R34 to reset capacitor C21 so that the controller output always follows the positioner output.

Primary-measuring instruments and control station have damped response and natural frequencies in excess of 4 cps. The controller break frequency is also approximately 4 cps.; that of output transducers is 1 cps. when operating into a volume of 65 cubic inches.

Schoppe & Faeser (German)

The circuit and schematic diagrams in Fig. 10-8 show the arrangement of this three-action all-electric controller. The cost of the controller will clearly depend on the cost of the magslips* (M) available to the makers.

The magslips are used as a-c. inductive potentiometers which give single-phase outputs of magnitude depending on the angular positions of the rotors.

Magslip M_1 accepts the input signal from the measuring unit and delivers a proportional output to the mixing transformer. The proportional band width is set on resistor R_p.

M_1 also feeds the motors m_1 and m_2 which, in turn, position magslips M_2 and M_3 through gear units G. The outputs of magslips M_2 and M_3 are fed into the mixing transformer to give integral and derivative actions respectively. It will

*The term "magslip" is used to denote angular position transmitting systems known by various proprietary names such as "Selsyn," "Autosyn," etc.

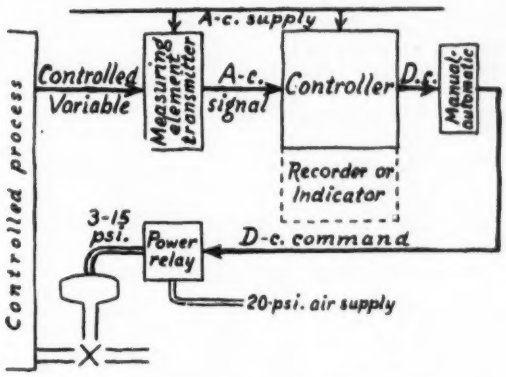

Fig. 10-9. Swartwout "Autronic" electronic control system.

be noticed that the systems m_1GM_2 and m_2GM_3 are similar systems, both of which will produce an output proportional to $\int \theta dt$. The output of magslip M_3 is, however, fed into the mixing transformer in the opposite sense to that of M_2 (and M_1). Hence the effect of the m_2GM_3 combination is to generate derivative action, whereas m_1GM_2 generates integral action.

The action times are set on the resistors R_I and R_D: proportional band width is set on R_p.

The mixing-transformer output is amplified to drive servomotor m_3, which positions the regulating unit. As shown in Fig. 10-8, the positional feedback is supplied by the magslip M_4 to the mixing transformer.

The design is such that no interaction (in the usual sense) occurs. Effective action times and proportional band will therefore be as read on the dials and it would be expected that high values of phase advance can be obtained.

The Swartwout Co.

"Autronic" Electronic Controller

This system comprises primary and final elements of customary sizes, but only miniature units for mounting on panels: the controller here described, the recorder, the indicator and the manual-control station (Fig. 10-9).

One distinctive feature of the controller is the conversion of the controlled variable into a proportional 60-cps. alternating voltage between 0 and 0.5 volt. All of this maker's measuring elements are designed to furnish an alternating voltage in this 0-to-0.5 volt range and hence are interchangeable. For flow, pressure, etc., conversion is effected by inductive pickups; for temperature, the transmitter comprises a platinum-resistance primary element and an adapter unit containing bridge components to provide the 0 0.5-volt alternating voltage.

Another feature of the controller is that its output is a direct current varying from 4 to 8 ma.

Electronically, the controller consists of four sections in cascade: proportional amplifier, phase-sensitive amplifier, derivative-action amplifier, and integral-action amplifier.

Proportional amplifier (A in Fig. 10-10): The signal voltage input (from the primary-element transmitter) and the desired-value voltage input are both connected to the a-c. amplifier. The difference between these two input voltages—the error signal—is amplified. The proportional bandwidth setting controls the gain of the a-c. amplifier, whose output is proportional to the error signal. The over-all amplification of the proportional amplifier is varied by feedback through the adjustable proportional-band network, calibrated from 3 to 200 percent band-width. The proportional amplifier is a 3-stage a-c. amplifier with resistance-capacitance coupling, and self-bias on the second two amplifier stages, as shown at A.

The phase-sensitive rectifier (between A and B) converts the a-c. output of the proportional amplifier into a d-c. voltage which is proportional to the error signal and of

correct polarity. The controller is changed from reverse to direct action by reversing the phase of the reference voltage to the phase-sensitive rectifier.

The derivative-action amplifier (B) has a network that causes the d-c. amplifier to have an output that varies in proportion to both the magnitude and the rate of change of the signal input.

When no derivative action is used with the controller, this amplifier has a voltage gain of one, obtained by feedback. When derivative action is used, feedback is through the derivative network, which delays the feedback. For sudden changes in voltage input, there is no feedback to reduce the normally high gain of this amplifier. Capacitor C_6, in combination with R_{15} interposes a delay in the feedback of triode V_{2A}: sudden input changes give greater output changes because capacitor C_6 shunts high-frequency components and reduces the negative feedback to the grid. Derivative time is adjustable from 0.05 to 8 minutes.

The integral-action amplifier (C) has an amplification of greater than 200 for steady-state or slowly-changing values of input. On more rapidly changing inputs, however, the integral network provides a transient voltage feedback which reduces the amplification. This provides the entire controller with an initially wide proportional bandwidth on sudden changes, which slowly reduces itself to a narrow band. The rate of integral action is adjustable from 0.03 to 20 repeats per minute.

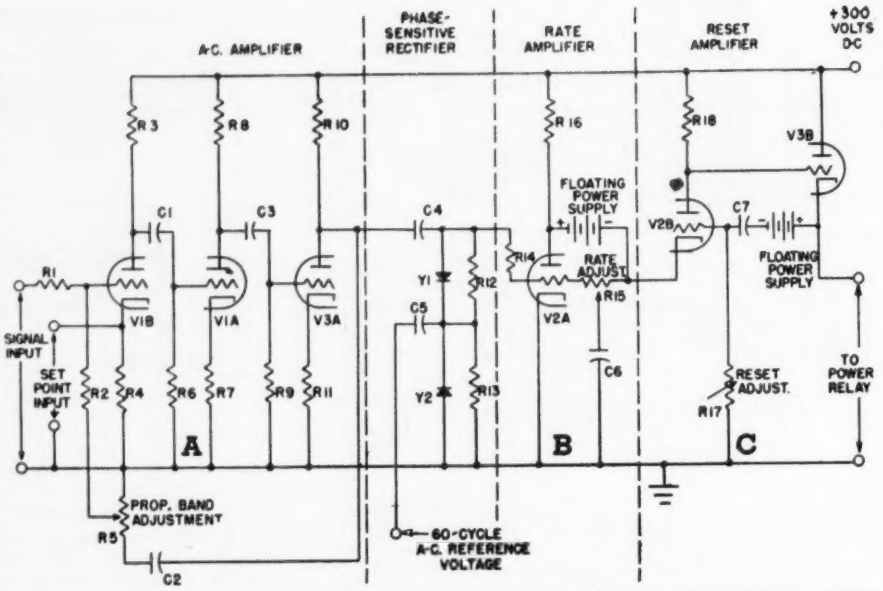

Fig. 10-16. Controller circuitry of "Autronic" controller. Separate derivative and integral action amplifier stages are used.

HIGH AND LOW TEMPERATURES

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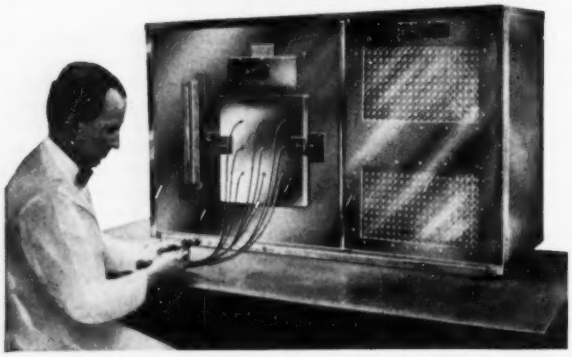

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April 26-30
American Society of Tool Engineers Industrial Exposition, Convention Hall, Philadelphia, Pa. For information write Harry Conrad, Ex. Sec., A.S.T.E., 10800 Puritan Ave., Detroit 21, Mich.

May 4-6
Electronic Components Symposium, Department of Interior Auditorium, Washington, D. C. For information write Arthur Zdobysy, Rm. 206, 1 Thomas Circle, N. W., Washington 5, D. C.

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Third International Aviation Trade Show, 71st Regiment Armory, New York. For information write Eugene P. Connelly, Aircraft Trade Shows, Inc., Hotel McAlpine, New York 1, N. Y.

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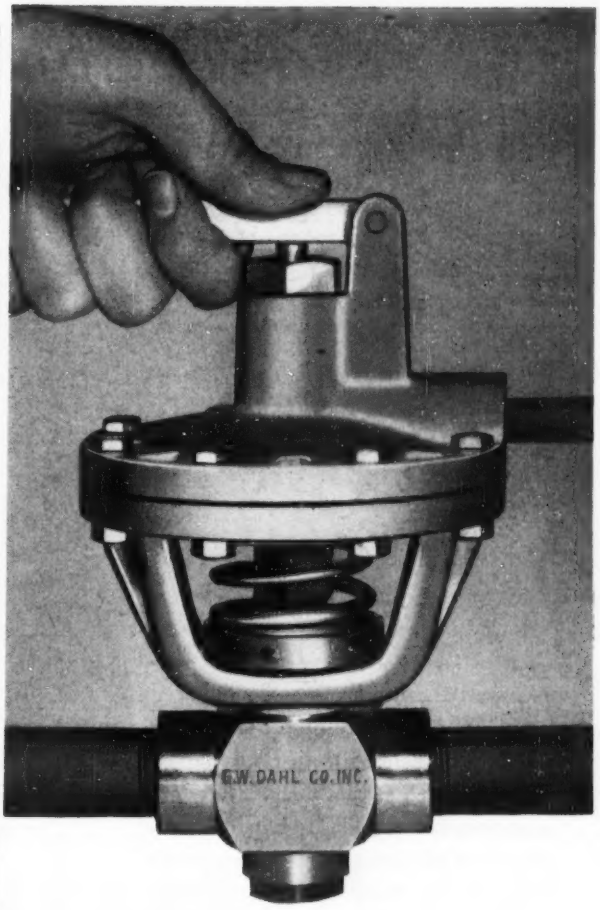

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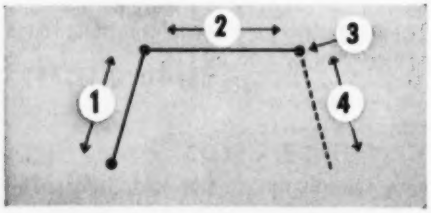

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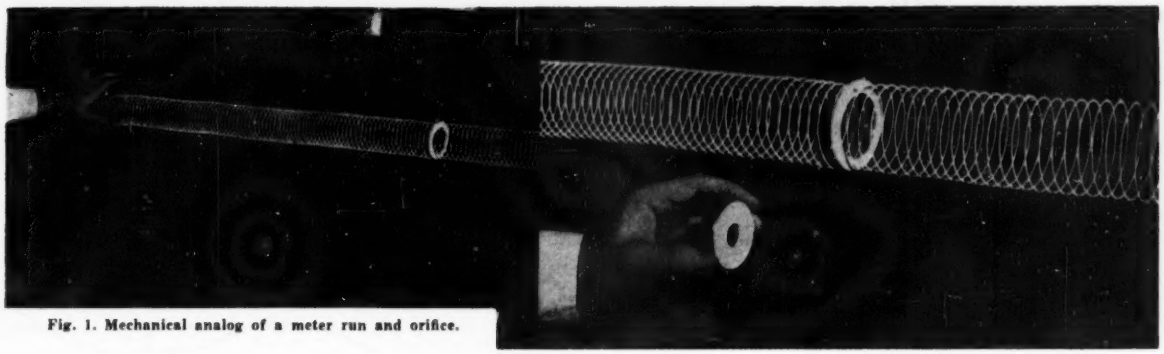


Fig. 1. Mechanical analog of a meter run and orifice.

Effects of pulsation on

ORIFICE METERING

Dynamic effect of pulsating flow in orifice metering is presented mathematically, showing the difficulties attendant to measurement of the errors produced. Techniques are recommended for reducing the pulsations by isolation of meter runs and reduction of pulsation amplitudes.

by RAYMOND C. BAIRD
The Fluor Corp., Ltd.

THIS article is a sequel to another on the concept of impedance mismatch caused by an orifice plate in a pipe, and the consequences therefrom[1]. It was pointed out that perhaps the major effects caused by impedance mismatch are a change of intensity of a pulsation wave propagating through the orifice, and a change in phase of this wave at the orifice. These two effects are principally functions of (1) orifice beta-ratio, (2) frequency of the pulsation wave, and (3) to a lesser extent, the flow rate. Pressure, temperature, gas density, and viscosity are influencing parameters, but their effects will not be considered.

This article presents the mathematical methods for calculating orifice metering error, including how pulsation causes an error in orifice differential pressure which in a complex wave cannot be satisfactorily determined at present because of insufficient empirical data.

May Meeting: Thursday, the 20th, Rio Hondo Country Club, Downey, Calif.
Feature: "Fundamentals of Combustion Control Systems" presented by A. Waxman, Hagan Corp.

It is assumed that the inferential-type recording meter reads accurately the actual pressure-differential occurring at the orifice taps.

Effect of Intensity Loss by Orifice Reflection

The intensity of a pulsation wave being transmitted through a pipe is the energy flow through unit cross-sectional area of the pipe per unit time. Whenever there occurs a sudden change of the cross-sectional area a fraction of the incident pulsation intensity is reflected. However, in an orifice-plate installation the sudden reduction in area is almost immediately followed by a sudden expansion to the same area as before; Stewart[2] shows that, neglecting viscosity and dissipation losses, a *sound wave* suffers no diminution of amplitude in passing through the orifice. This follows if the thickness of the orifice plate is small compared to the sound wavelength. Thus it might appear that reflection of pulsation in a meter run has little effect in causing metering error. On the other hand, actual measurements show[1] that reductions in amplitudes of more than fifty percent can occur for components of a complex pulsation wave; pulsation waves occur simultaneously upstream and downstream of the orifice in a meter run.

The apparent discrepancy with Stewart's results can be resolved when it is remembered that Stewart developed his expression for sound pressures which are infinitesimal compared to pipeline pulsation-wave pressures. In addition, he did not consider the effect of a static pressure drop caused by a superimposed gas flow through the orifice. Furthermore, he ignored viscosity and any frictional dissipation of sound energy. We know from actual measurements that a reduction in amplitude of a pulse wave will occur when passing through an orifice, the exact amount being a complicated function of pressure, temperature, viscosity, flow rate, incident pulse amplitude, and orifice beta ratio.[3]

Phase Shift

For an orifice, Stewart[2] shows that for a sound wave (with zero net gas flow) a phase shift is introduced between the incident and transmitted waves. He developed an expression for this shift in terms of beta ratio (β) and sound velocity (c).

The application of his theoretical result to actual meter run measurements shows it to be far too conservative[1].

Mechanical Analog

Fig. 1 shows a mechanical analog of a meter run and provides a visual picture of the way in which a wave propagates through an orifice.

Compressional waves can be made to travel down the "pipe" (spring) by suddenly releasing energy stored in the compression of a few turns of the spring at one end. Upon reaching the "orifice" (a mass in the form of a ring) a fraction of the wave energy is reflected. The on-going transmitted wave can be seen to be less intense; careful scrutiny reveals that a phase difference is introduced between incident and transmitted waves at this point. A change in "beta ratio" is accomplished by increasing the mass of the ring by insertion of another ring which reduces the size of the orifice "aperture."

Effect of Phase Shift on Differential Pressure

Fig. 2 illustrates the instantaneous pressure distribution near an orifice with pulsative flow. The recurrent pulse wave, traveling from left to right, is assumed to be sinoidal. (It may be a single component of a complex wave.) Notice the phase shift and reduction of pulse amplitude.

The incident and transmitted waves can be described mathematically

$$p_1 = P_1 + A \sin \omega t$$
$$p_2 = P_2 + B \sin (\omega t - \phi)$$

where p_1 and p_2 are, respectively, instantaneous pulsation pressures at upstream and downstream orifice taps; P_1 and P_2 are, respectively, static pressures (with no pulsation present) at upstream and downstream orifice taps; A and B are, respectively, peak amplitudes of upstream and downstream pulse waves; ω is $2\pi f$; f is pulsation frequency; and ϕ = phase shift.

The instantaneous differential pressure is

$$\Delta p = p_1 - p_2 = (P_1 - P_2) + A \sin \omega t - B \sin (\omega t - \phi) \quad (1)$$

Effect of Phase Shift on Time-Averaged Differential Pressure

The effect of ϕ on the time-averaged value of Δp is zero. This can be shown by integrating the expression for Δp over a complete cycle or from (t = O) to (t = T) where (T = 1/f), and dividing by T:

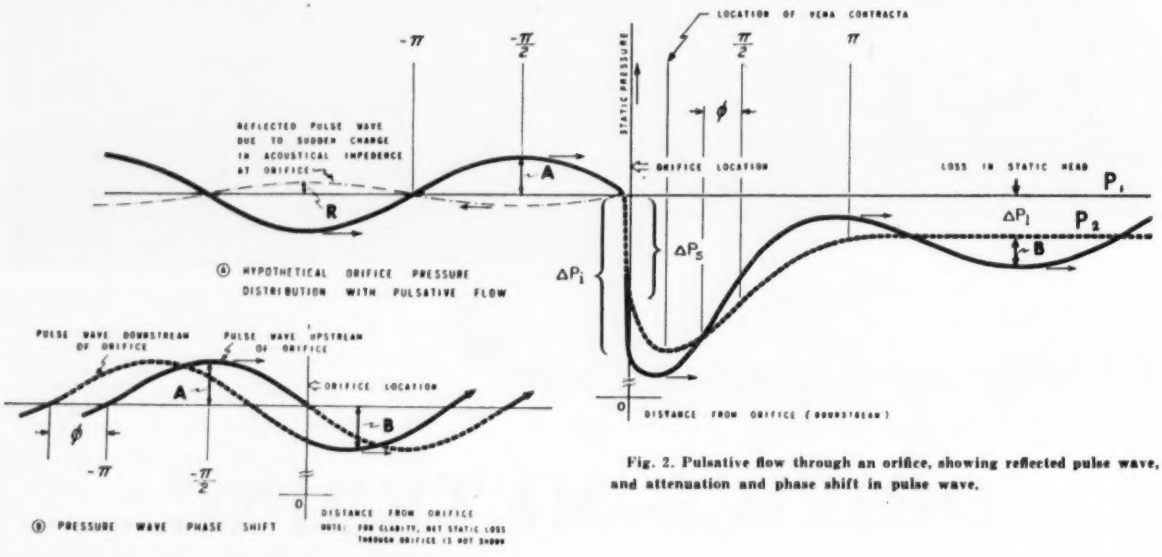

LOCATION OF VENA CONTRACTA
STATIC PRESSURE
REFLECTED PULSE WAVE DUE TO SUDDEN CHANGE IN ACOUSTICAL IMPEDENCE AT ORIFICE
ORIFICE LOCATION
LOSS IN STATIC HEAD
HYPOTHETICAL ORIFICE PRESSURE DISTRIBUTION WITH PULSATIVE FLOW
PULSE WAVE DOWNSTREAM OF ORIFICE
PULSE WAVE UPSTREAM OF ORIFICE
DISTANCE FROM ORIFICE (DOWNSTREAM)
PRESSURE WAVE PHASE SHIFT
DISTANCE FROM ORIFICE

Fig. 2. Pulsative flow through an orifice, showing reflected pulse wave, and attenuation and phase shift in pulse wave.

$$(\Delta p)_{ave} = \int_0^T [(p_1 - p_2)/T]dt$$
$$= 1/T \int_0^T [P_1 + A \sin \omega t - P_1 - B \sin (\omega t - \phi)]dt$$
$$= (P_1 - P_2) + (A/\omega T)(1 - \cos \omega T) + (B/\omega T)[\cos (\omega T - \phi) - \cos \phi] \quad (2)$$

Thus $(\Delta p)_{ave}$ is made up of the "static" component $(P_1 - P_2)$ plus a dynamic component. However, since $(T = 1/f)$, and $(\omega = 2\pi f)$, equation (2) becomes

$$(\Delta p)_{ave} = (P_1 - P_2)$$

and, accordingly, one would be inclined to think that pulse phase shift and intensity loss have no effect on flow-meter accuracy.

Effect of Phase Shift and Intensity Loss

To help understand how pulsation can produce error in a time-integrated flow-meter chart, put equation (1) in simpler form. Expansion of the trigonometric term and factoring gives

$$\Delta p = (P_1 - P_2) + (A - B \cos \phi) \sin \omega t + (B \sin \phi) \cos \omega t$$
$$= C + A' \sin \omega t + B' \cos \omega t \quad (3)$$

where C is $(P_1 - P_2)$, the static or d-c. component[1]; A' is $A - B \cos \phi$; B' is $B \sin \phi$. A' and B' are the dynamic or a-c. component.

The dynamic portion of equation (3) can be replaced by one involving a single trigonometric term by finding the peak value of $(A' \sin \omega t + B' \cos \omega t)$ at a point where $(\omega t) = \sigma$. σ is the phase angle for the new equation and is determined by setting the first derivative of the dynamic portion of equation (3) equal to zero. That is,

$$(d/dt)(A' \sin \omega t + B' \cos \omega t) = 0$$
$$A' \cos \omega t - B' \sin \omega t = 0$$
$$\sin \omega t / \cos \omega t = A'/B' = \tan \sigma$$

$$\sigma = \tan^{-1}(A'/B') \quad (4)$$

The amplitudes of $(A' \sin \omega t)$ and $(B' \cos \omega t)$ at $(\omega t = \sigma)$ are:

$$A'' = A' \sin \sigma$$
$$B'' = B' \cos \sigma \quad (5)$$

The peak amplitude of the combined waves is

$$D = (A'' + B'') = A' \sin \sigma + B' \cos \sigma$$

and the final form of the a-c. or dynamic component of (Δp) becomes

$$(\Delta p)_{AC} = D \cos(\omega t - \sigma)$$

therefore $(\Delta p) = C + D \cos(\omega t - \sigma)$ (6)

and we see that the differential pressure during pulsative flow varies above and below a mean value, C, by as much as D. This oscillatory amplitude and σ are functions of phase shift and intensity loss through the orifice as shown in the following (from equation 3, 4, 5):

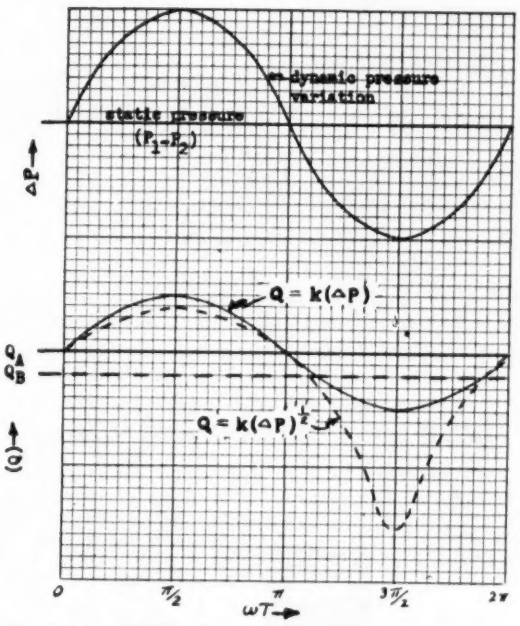


Fig. 3. Effect of differential-pressure oscillation on integrated flow.

$$(\Delta p) = (P_1 - P_2) + [(A - B \cos \phi) \sin(\tan^{-1} A/B) + B \sin \phi \cos(\tan^{-1} A/B)] \cos(\omega t - \tan^{-1} A/B)$$

This shows that the D factor of equation (6), the amplitude of the oscillating portion of Δp, generally increases with increased phase shift and intensity loss. If, as before, equation (6) is integrated to find the time-averaged value of (Δp) we obtain the same result as previously—that is,

$$\Delta p_{ave} = P_1 - P_2.$$

Dependence upon Orifice Equation

However, if it is assumed that the orifice equation holds true at any instant during the pulse cycle so that

$$Q = k(\Delta p)^{\frac{1}{2}}$$

where Q is flow rate, k is a constant, and Δp is pressure drop across orifice, then the total quantity of fluid flowing through the orifice in one cycle is

$$W = \int_0^T Q \, dt = k \int_0^T (\Delta p)^{\frac{1}{2}}$$

$$= k \int_0^T C + D \cos(\omega t - \sigma)^{\frac{1}{2}} \, dt \quad (7)$$

The important factors in this integral insofar as pulsation is concerned are σ and C because these have been shown to depend on pulsation intensity and orifice beta ratio. Because it enters as a square-root function, the dynamic component of Δp does not drop out when integrating to find the quantity of flow during a complete cycle. The reason for this can be seen by reference to Fig. 3. Curve A shows the variation in flow rate during the cycle where $Q_A = k(\Delta p)$. Q_A is the corresponding average rate for the cycle. It would have the same value regardless of whether or not pulsation were present. Curve B shows the variation where $Q = k(\Delta p)^{\frac{1}{2}}$. The average rate in this case, Q_B, will obviously be less than Q_A, due to the fact that the exponent of (Δp) is less than unity.

It is apparent from equation (7) and Fig. 3 that the amount of flow error is a function of the relative magnitudes of C and D. The smaller C is as compared to D, the larger will be the error. This is another way of saying what has been observed for many years in the field, that increasing the average differential pressure by using a smaller orifice will, in general, reduce metering error.

Result of Pulsative Flow

The resultant effect, therefore, of the presence of a dynamic component in Δp is to increase the effective pressure drop through the orifice for a specified time-averaged flow rate. Accordingly, if pulsation is suddenly introduced in a system containing an orifice meter, the maintenance of the same flow rate requires that one or the other of the following possible readjustments of upstream and downstream mean static pressures takes place: (1) P_1 increases while P_2 remains the same, (2) P_1 remains the same while P_2 decreases, or (3) P_1 increases while P_2 decreases. The last is most likely to occur.

The average orifice-meter operates with a differential pressure on the order of only 25 to 50 inches of water at a static pressure measured in hundreds of psi. Hence, the slight alterations in upstream and/or downstream static pressures necessary to maintain the same flow rate after the imposition of pulsative flow would be so small as to make their measurement extremely difficult. These slight alterations, however, would appear at the flow meter as an appreciable percentage of the differential pressure. The result would be an error in the indicated differential pressure at the flow meter, which would render inaccurate any flow quantity calculations based on integration of the chart.

Remedy

There are two courses of action to take in eliminating orifice-meter error caused by pulsative flow. One is to develop some means to measure the amount of error and then apply corrections. This probably would be expensive and time consuming.

The best approach appears to be the elimination of pulsative flow because the orifice meter has proved to be accurate and dependable when operating under steady flow conditions.

Conclusion

Although nothing has been said about the self-generation of pulsation by a meter-run installation, acoustical resonance of the lines connecting flow-meters to orifice taps, or the effect of pulsation on the flow-meter itself [1], the primary difficulty in metering pulsative flow is due to acoustical reaction of the orifice to pulsation.

Therefore, if orifice metering is used for flow measurement, steps should be taken to insure that compressor-induced pulsative flow is at a minimum. This can be accomplished in several ways. In order of preference: (1) Isolation of meter runs from sources of pulsation by filter-type pulsation dampeners. (2) Reduction of pulsation amplitude by installation of adequately-sized surge chambers [4]. (3) Reduction of pulsation in the meter run by either "pinching back" on block valves located between meter runs and pulsation sources, or inserting pressure dropping orifices at such locations.

Bibliography

1. Baird, R. C., and Bechtold, I. C., "The Dynamics of Pulsative Flow Through Sharp-edged Restrictions With Special Reference to Orifice Metering," Transactions of ASME, Vol. 74, No. 8, Nov. 1952, p. 1381, (see also *Petroleum Engineer*, July, 1952, and *Instruments*, April 1952).

2. Stewart, G. W., and Lindsay, R. B., *Acoustics*, D. Van Nostrand Co., Inc., 1930, 4th printing, Sec. 3.6.

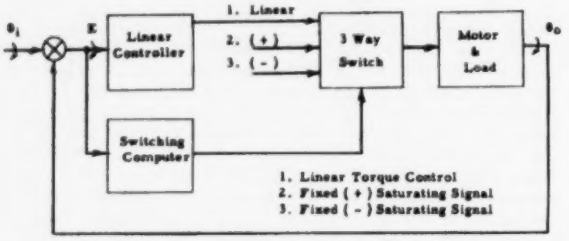
3. Yates, C. F., "Effect of Pulsation on Gas Measurement," Proceedings of The Ninth Annual Appalachian Gas Measurement Short Course, 1949, Tech. Bull. No. 29, Engrg. Exp. Station, West Virginia University, (pub. by W. Va. Univ.), p. 486.

4. Chilton, E. G., and Handley, L. R., "Pulsations in Gas-Compressor Systems," Transactions of ASME, August, 1952, p. 931.

Briefs . . .

Multiple-mode Servomechanisms

This paper describes the results of experimental tests on servomechanisms employing the principles of multiple-mode operation. This type of system operates at maximum torque,



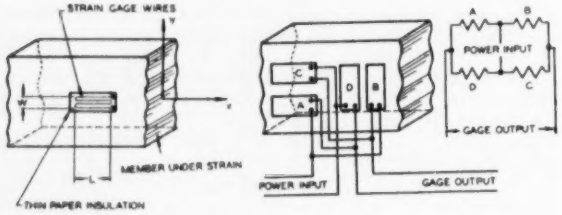
reversible polarity, for all values of error greater than some predetermined allowable maximum, and switches to conventional linear servo operation for all values of these variables less than this maximum.

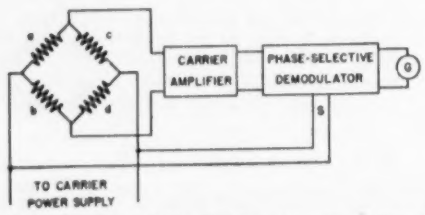
This type of system, when compared to a conventional system of limited torque and torque proportional to error and its derivatives, shows an improvement theoretically in time response since the rate of reducing error is always the greatest possible in the maximum torque mode. The linear mode of operation is included only for reasons of stability and is chosen small enough so as not to cause a deterioration of response. (*From new 22-page brochure "Application of Nonlinear Techniques to Servomechanisms, Cook Research Laboratories, 8100 Monticello Ave., Skokie, Ill.*)

For this literature circle **401** on inquiry card.

Measurement of Strain

The fact that the resistance of a wire will increase when it is stretched was discovered by Lord Kelvin and P. W. Bridgeman. Resistance change is caused both by a dimen-





sional change and the Bridgeman effect. Illustrations show strain gage for strain in X-direction; bridge made up of two active gages A and C and two temperature-compensating gages B and D; carrier system permitting zero galvanometer current for zero strain. (*From booklet "The Measurement of Strain," Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo. Price: 25 cents.*)

For this literature circle **402** on inquiry card.

Thermostatic Bimetal Calculations

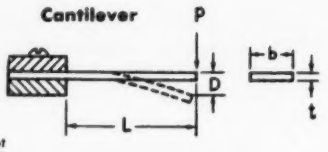
(1) $D = \frac{k_{DS}(T_2-T_1)L^2}{t}$

(2) $P = \frac{k_{PS}Db t^3}{L^3}$

(3) $P = \frac{k_{DS}\, k_{PS}\, (T_2-T_1)\, bt^2}{L}$

(4) $PD = \frac{k^2_{DS}\, k_{PS}\, (T_2-T_1)^2\, Lbt}{d}$

Cantilever



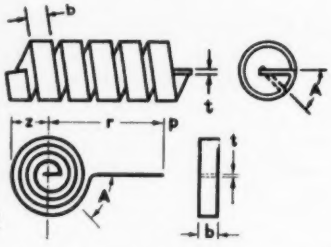
Spiral or Helix Coil

(9) $A = \frac{k_{DC}\, (T_2-T_1)\, L}{t}$

(10) $P = \frac{k_{PC}\, Abt^3}{Lr}$

(11) $P = \frac{k_{DC}\, k_{PC}\, (T_2-T_1)\, bt^2}{r}$

(12) $PA = \frac{k^2_{DC}\, k_{PC}\, (T_2-T_1)^2\, Lbt}{4r}$



(*From new 36-page Booklet "Successful Applications of Chace Thermostatic Bimetals, W. M. Chase Co., 1601 Beard Ave., Detroit, Mich.*)

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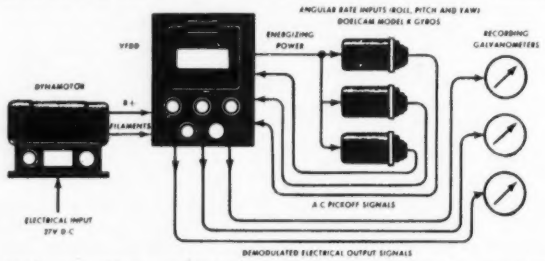
Flight Test Instrumentation

The Doelcam VFDD is a precision power supply and three-channel Demodulator Unit designed specifically to serve as the link between sensing instruments and oscillo-



graph recording equipment. In the Rate Measuring System, for example, the VFDD supplies voltage-regulated and frequency-stabilized 400-cps. power for the proper excitation of one to three Rate Gyros and also demodulates the a-c. pick-off rate signals for use with recording galvanometers. (*From new Bulletin VF, Doelcam Corp., Soldiers Field Rd., Boston 35, Mass.*)

For this literature circle **404** on inquiry card.

Semiconductors, Transistors

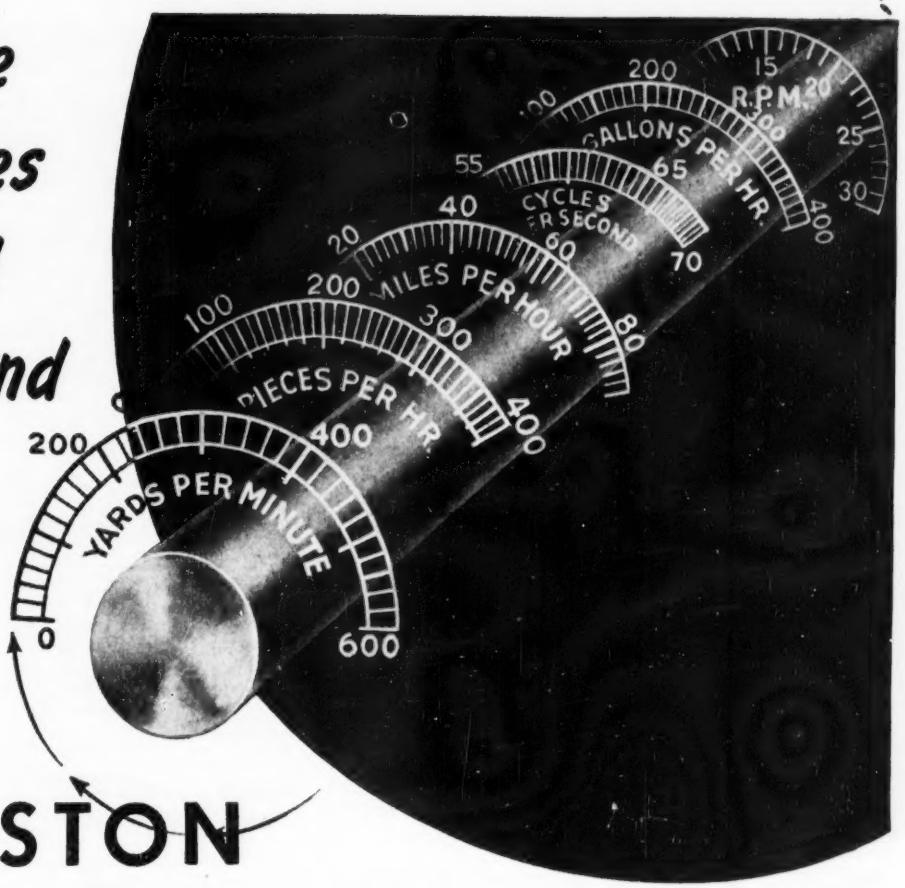
Work in the field of semiconductors during the past year had some highly significant results.

Gold-bonded germanium diodes similar in design to present "whisker" diodes but having improved forward conductance and back resistance were introduced. And developmental power transistors were operated with thermal stability and a usable power gain above 50-watt collector dissipation.

Junction transistors came of age as stable and capable amplifying devices suitable for many applications previously reserved for vacuum tubes and magnetic amplifiers.

Incorporated in the new transistors are many important

If some part goes 'round and 'round



...WESTON *Electrical Tachometers*

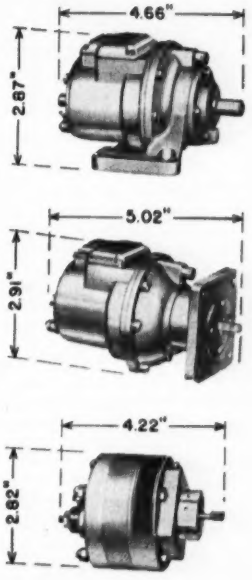
can provide a simple, accurate key to control!

Wherever instant, accurate measurement furnishes the key to precise control, equipment manufacturers now build-in WESTON Electrical Tachometers. For no other method approaches the electrical tachometer for simplicity, ease of installation, overall dependability and ready adaptability to problems of design.

The specially designed WESTON A-C and D-C Tachometer Generators, for example, save up to 50% in size and weight, and are available in forms to permit wide flexibility in mounting, and in connection arrangements. The WESTON Indicators, too, are available in required sizes and shapes, calibrated in any function of the RPM. Available to directly indicate speeds as low as 1/10 RPM up to 80,000 RPM.

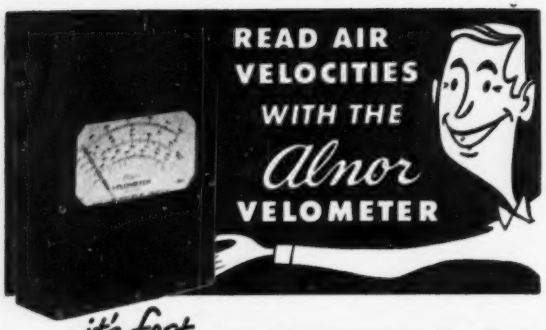
Other advantages of electrical tachometers such as . . . multiple indications from one generator . . . remote indications . . . dependable, long-term accuracy . . . and low maintenance, warrant full investigation. Complete details gladly sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Space-saving • Weight-saving WESTON Generators



WESTON *Instruments*

For more information circle **108** on inquiry card.



it's fast . . . you get instant, precise readings directly from scale face . . . no need for reference charts or calculations. Measure air flow through ducts, grilles, motors, spray booths, etc., or in the open.

it's accurate . . . brings laboratory standards of air velocity measurement to the production line, mine, mill . . . anywhere. Needs no special care or handling . . . anyone can use it and get accurate results.

it's portable . . . completely self-contained, hand-held. Rugged construction and sturdy case protect the Velometer from usual hazards of portable use. Available in scale ranges to 24,000 f.p.m. Wide selection of jets and fittings assures adaptability of Alnor Velometer to your application. Get full details and prices, write for Bulletin 2448-G. Illinois Testing Laboratories, Inc., Rm. 518, 420 N. La Salle St., Chicago 10, Ill.

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For more information circle **109** on inquiry card.

Now Save 36%
On Installation Time
with IMPERIAL *Hi-Duty*®
TUBE FITTINGS

Just push tube into fitting without removing nut and tighten . . . that's all.

Repeated, thorough tests reveal that IMPERIAL HI-DUTY FITTINGS can be assembled in 36% less time than regular COMPRESSION TYPE FITTINGS . . . and in 71% less time than FLARE TYPE FITTINGS. These are spectacular savings.

Fitting is furnished with integrated nut and sleeve assembled. To get a tight joint, simply insert tube into fitting and tighten nut. No loose sleeve to drop.

MAKES FAR STRONGER JOINTS because sleeve is always in perfect alignment and because its design minimizes deformation of tubing. Hi-Duty Fittings remain leakproof even under severe service; withstand over 5 times as much vibration as ordinary compression or flared fittings.

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For more information circle **110** on inquiry card.

BRIEFS—CONTINUED

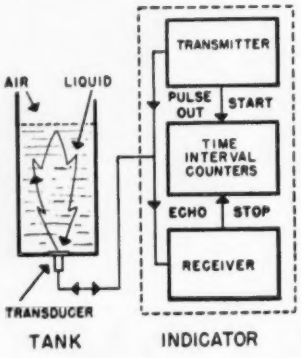
features, among them: vacuum-tight construction with all-welded metal and glass housings, high-frequency cutoff, and high power capability. Their advantages of small size, lightweight (0.05 ounce), and practically unlimited life open up new fields of electronic application.

Newly developed techniques in the manufacture of junction transistors halved their cost.

The first instrument developed by GE for testing transistor equipment is a go no-go alpha cutoff checker that operates at frequencies up to 10 megacycles. It has power supplies flexible enough to handle all p-n-p or n-p-n junction transistors. (*From Vol. 57, No. 1 issue of "GE Review," Schenectady 5, N. Y.*)

For this literature circle **405** on inquiry card.

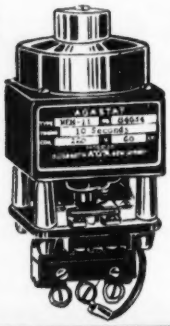
Sonic Level Measurement

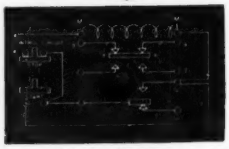


Bogue Sonic Liquid Level Indicators utilize echo sounding techniques for determination of liquid levels. A sound pulse periodically is directed through the liquid to the surface where it is reflected back as an echo. The time required for the pulse to travel the path up and back is measured and converted to represent liquid level directly in feet and decimal fractions. Measuring range is 1.00 to 99.99 feet;

NEW!

AGASTAT
Trademark
TIME DELAY RELAYS
with Remote Push Button Control





Wiring diagram NEH-11 AGASTAT

An auxiliary "hold-in" switch affixed to the bottom of these pneumatic relays makes possible a remote push button control of the time delay. Delays easily adjustable from 0.1 second to 10 or more minutes. A.C. and D.C. units, single or double break contacts. All are lightweight, compact, easily mounted and low in cost.

Write for specifications—and ask our application engineers for help with your timing problem. Address Dept. A9-49.

A'G'A DIVISION ELASTIC STOP NUT CORPORATION OF AMERICA
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing

For more information circle **111** on inquiry card.

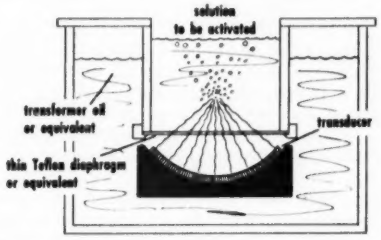
level resettability is ± 0.01 ft.

Echo pulses are ordinarily reflected back from the surface of the liquid; however, the line of demarcation, or interface, between immiscible liquids also reflects sufficient energy to allow the system to gage these obscure interface levels. (*From new Bulletin S-68, Boque Electric Mfg. Co., Paterson 3, N. J.*)

For this literature circle **406** on inquiry card.

Ultrasonic Cleaning

Ultrasonic cleaning employs the piezoelectric characteristic of barium titanate . . . which changes shape with the alternations of an electric potential applied to it. When

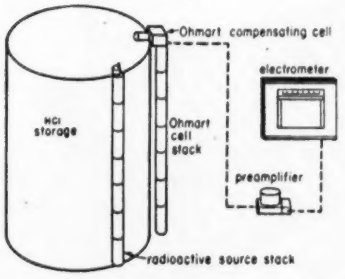


energized with AC of 50 to 500 kc., the resultant vibration propagates high-frequency energy into the liquid in contact with it.

When electrically-conductive cleaning solvents, such as acids or alkalis, must be used, a special vessel similar to that shown may be employed. The transducer is immersed in oil, and the ultrasonic energy is transmitted through a thin Teflon or metal diaphragm to the solvent in the upper chamber. (*From new "Sonogen" Bulletin, Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn.*)

For this literature circle **407** on inquiry card.

Gamma-ray Level Measurement



Atomic energy development has added a new system of measuring and controlling liquid level. It is based upon the change in the number of gamma rays penetrating a layer of liquid as the thickness of the interfering liquid layer varies. The source of the gamma rays is a minute quantity of radioactive material, such as commercially available radium salts. The gamma radiation passes through the containing vessel and is detected by a Geiger counter or Ohmart gas-ionization cells on the outside.

Since no opening in the tank is necessary, the gamma-ray system can solve several different types of difficult liquid level problems. The level of highly corrosive fluids, liquids with sludge and foam, sticky or slimy liquids, and foods (in which case sanitary laws prohibit stuffing boxes) can be measured by gamma ray penetration. This method is suited for extreme temperatures and pressures. (*From new 26-page Bulletin 1160, covering all types of level instrumentation, Minneapolis-Honeywell Reg. Co., Indus. Div., Phila. 44, Pa.*)

For this literature circle **408** on inquiry card.

Regulated D-c. Supply

A fraction of the power supply output voltage is compared against a standard cell. The difference is coupled to a Chopper Amplifier and rectifier. The output of the rectifier is fed through a non-linear filter to a DC Driver Ampli-

for more accurate pressure control

the NEW Klipfel

PILOT-OPERATED REDUCING VALVE No. 933

OTHER OUTSTANDING KLIPFEL CONTROLS:

No. 1549 Pilot - operated Temperature Regulating Valve . . . sensitive, positive control for high pressure, larger sizes.

No. 1649 Combination Temperature and Pressure Control . . . single main valve with temperature and pressure control saves cost and labor!

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When you need "on-the-button" steam pressure reduction, specify the new Klipfel Pilot-Operated Reducing Valve.

Although extremely sensitive, its simple operation insures trouble-free service. Downstream pressure is sensed by the diaphragm of the pilot valve. The pilot valve uses upstream pressure to open the main valve if downstream pressure is too low; if too high, pressure is bled off to partially close main valve.

The next time you order a reducing valve, get the new standard for accurate control and low cost operation . . . Klipfel No. 933 Reducing Valve. Detailed literature on request.

Klipfel VALVES, INC.
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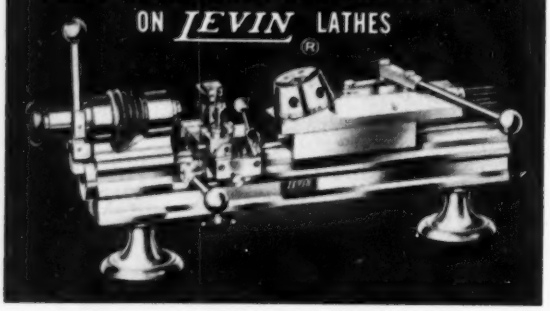
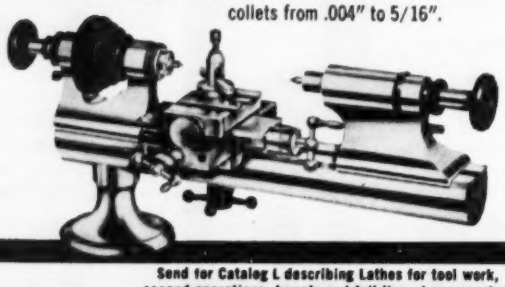
Call your supply house or Klipfel Distributor listed in yellow pages.

For more information circle **112** on inquiry card.

SMALL INSTRUMENT PARTS ARE MADE BEST
ON LEVIN® LATHES



Twenty-three models for all types of work. 4" swing, Bed Length 12" or 18"; over 100 stock sizes of collets from .004" to 5/16".

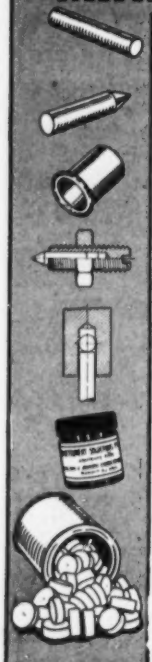


Send for Catalog L describing Lathes for tool work, second operations; turrets and full line of accessories.

LOUIS LEVIN & SON, INC., 3610 S. Broadway, Los Angeles 7, Calif.

For more information circle **113** on inquiry card.

MINIATURE PARTS



CUSTOM MANUFACTURE OF SMALL PARTS

• Shafts, Staffs and Pivots of Special Pivot Steel, Heat-Treated and Metallographic-Polished. • Tubular Products up to 3/8" Diameter, Cut, Flared, Swaged, Formed and Burr-Free Alloy or Silver Plated. • Screw-Machine Products up to 3/16" Diameter. • Roll-Threading and Knurling to Close Tolerances. • Centerless and Surface Grinding with Special Facilities for Ceramic Rods and Shapes. • Light Punch-Press Work.

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• A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Knurling, Thread-Rolling, Swaging, Drilling, Milling, Burr Removing, Metallographic, Polishing, Barrel-Plating in Alloy or Silver.

ASSEMBLY SUPPLIES

• "Welton" Non-Corrosive Instrument Solder Paste. • "Weltonoil" Treated Buttonwood Pith.

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In Connection with the Design and Fabrication of Precision Miniature Parts.

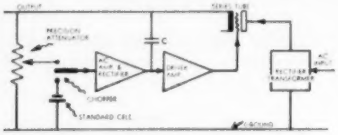
ENGINEERING ASSISTANCE ON ALL ITEMS

Welton V. Johnson
ENGINEERING COMPANY INC.
87 SUMMIT AVENUE • SUMMIT, N. J.

For more information circle **114** on inquiry card.

BRIEFS—CONTINUED

fier. AC signals from the output are fed through the capacitor (C) to the Driver Amplifier. This amplifier controls the series tubes, thus correcting for any change from the desired output voltage. The AC signal fed to the Driver Amplifier assures low output hum and noise and maintains low AC output impedance at high frequencies.



The non linear filter, a unique technique, not only reduces the ripple from the rectified output of the Chopper Amplifier, but also is important in the stabilization of the overall feedback system. For optimum filtering and stability a fairly long time constant is desired. The long time constant, however, makes the system sluggish and increases the transient recovery time. The non-linear filter has an extremely short time constant when the error present in the system is large. As the error is reduced and the system approaches balance, the time constant of the filter increases. At equilibrium, the time constant of the filter is quite long and assures stable operation. (*From new 4-page brochure, Kalbfell Laboratories, Inc.,* 1090 *Morena Blvd., San Diego, Calif.*)

For this literature circle **409** on inquiry card.

Dynamometers

Dynamic Dynamometers fall into four general categories: (1) Absorption Dynamometers—used to absorb and measure power delivered by a motor or prime mover, (2) Motoring

Fact-filled folder on request . . . showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.

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Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . . easily, simply, quickly . . . tracing from a master with the GREEN ENGRAVER.

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Green Instrument Co.
INCORPORATED

383 PUTNAM AVE., CAMBRIDGE, MASS.
See us at Booth 2016 at the A.S.T.E. Show

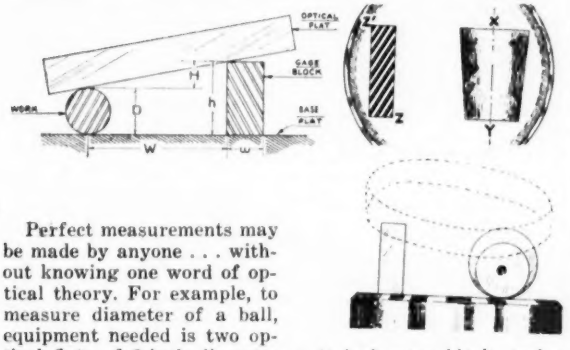
For more information circle **115** on inquiry card.

Dynamometers, (3) Universal Dynamometers, (4) Special Purpose Dynamometers.

The absorption dynamometer is basically an eddy-current brake mounted in trunnion bearings. A motoring dynamometer is capable of driving a machine, and at the same time measuring the torque required. A universal dynamometer is a dual purpose unit able to perform the functions of the absorption dynamometer and the motoring dynamometer as well. (*From new Bulletin DB-1, Dynamatic Corp., Kenosha, Wis.*)

For this literature circle **410** on inquiry card.

Optical Gaging



Perfect measurements may be made by anyone . . . without knowing one word of optical theory. For example, to measure diameter of a ball, equipment needed is two optical flats of 2-inch diameter, a ¼-inch gage block, and a monochromatic light source. Tilt of upper optical flat produces bands, the number of which indicates the difference in height of gage block and piece to be measured. Right-hand illustration shows measurement of taper of a plug gage, also with two optical flats and a gage block. Number of bands across short edge of gage block indicates diameter

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DIAL THERMOMETERS

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Brass Bulb for economy or Stainless Steel Bulb for corrosion resistance.

Extremely accurate, compact, durable—Marshalltown dial thermometers are the world's finest instruments for the indication of liquid or gas temperatures. Positive, direct with full freedom actuation—no gears or pinions. A choice of many standard scales from -40° F. to 500° F.

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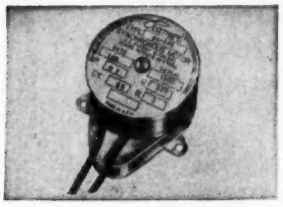
SYNCHRONOUS TIMING MOTORS STOP AND START *INSTANTLY!*



CHECK THESE OUTSTANDING *FEATURES...*

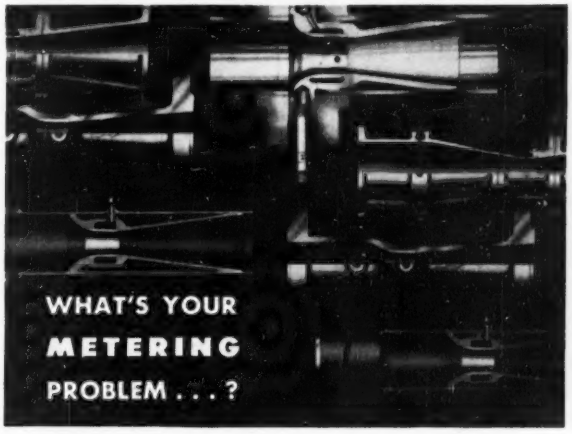
- Instantaneous Response
- 30-Inch Ounces Torque at 1 R. P. M.
- Runs Only at Synchronous Speed
- Runs Equally Well in Any Position
- Controlled Rotation or Dual Rotation
- Replaceable Coils
- One- or Two-Way Friction

Write for Cramer Timing Device Catalog or specify Bulletin No. 10A for complete information on the Model SX Motor.

the R. W. CRAMER COMPANY
BOX 5, CENTERBROOK, CONN.

SCR88

For more information circle **116** on inquiry card.



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BIF METERS REGIS CONTROLS

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DC-AC CHOPPERS
Triple Certified
FOR MILITARY USE
0—500 CPS
1. Each lot is sample life tested to prove 1000 hours life —55°C., +85°C.
2. Every Chopper is given two complete operating tests —55°C., +25°C., +85°C. This is double-proof of stamina. Nothing left to chance.
3. Gold contacts are used exclusively in order to obtain superior results in the vital 0–1½ volt d-c range.
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New

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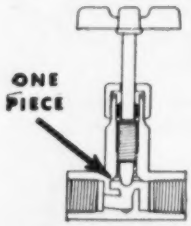
Needle Valves

MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales affiliate of Jas. P. Marsh Corporation*
Dept. 42, Skokie, Ill.

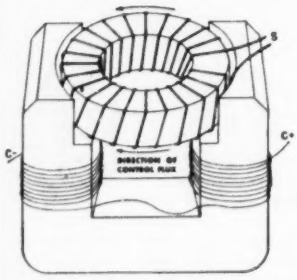
For more information circle **120** on inquiry card.

BRIEFS—CONTINUED

of plug. Number of bands along long edge indicates the taper. (*From new brochure "Shop Measurements with Light Waves to Millionths of an Inch," Acme Scientific Co., 1450 W. Randolph St., Chicago, Ill.*)

For this literature circle **411** on inquiry card.

Variable Inductors



"Vari-L" is a high-Q toroidal inductor with controllable inductance. A permanent magnet, used for bias, is positionable to provide the desired starting inductance, which then may be modulated upward or downward by the control current. The toroidal core is wound on a low saturation-flux-density magnetic core and is placed in the air gap of an electromagnet . . . Uses include inductor in the swept oscillator of the "Vidigage" ultrasonic thickness tester of Branson Instruments, Stamford, Conn., in which frequency deviation is controllable from 5 to 105 percent. (*From new brochure of Vari-L Co., Inc., P.O. Box 1433, Stamford, Conn.*)

For this literature circle **412** on inquiry card.

Microwave Calorimetry

Microwave calorimeters can be used for (1) measuring radar power, (2) absorbing power from any source of microwave energy, (3) calibrating microwave test equipment, (4)

"Helinews"
Computing with
Servo-Driven Potentiometers
by F. R. Bradley and R. D. McCoy
Reprints of this significant paper, which first appeared in the September 1952 issue of TELE-TECH & ELECTRONIC INDUSTRIES, are still available. A copy is yours for the asking.
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Helipot corporation
a division of BECKMAN INSTRUMENTS, INC.
SOUTH PASADENA, CALIFORNIA
. . . first in precision potentiometers
234

For more information circle **121** on inquiry card.

combining microwave calorimetry (heat rise in liquids or gases) and microwave spectroscopy (molecular resonance), (5) evaluating fluids in medicine and biophysics, and (6) evaluating industrial liquids as to quality, calory count, or chemical composition, including fuels, lubricants, dairy products, etc. (*From new brochure of Sightmaster of Calif. Co., Gillespie Airport, Santee, Calif.*)

For this literature circle **413** on inquiry card.

Brinell Hardness

Hardness, as it applies to metals, has probably never been satisfactorily defined. The common concept of hardness within the metal-working industry, however, is "resistance to indentation." It was perhaps this concept which, early in the twentieth century, led Dr. J. A. Brinell to develop a ball test for accurately measuring the hardness of metals.

The Brinell test made it possible for two individuals at two different places to test a given specimen for hardness and arrive at the same result. More important, it created a "language"— the Brinell Hardness Number—that has become universally understandable.

The Brinell tests consists of applying a known load on a surface by means of a 10-mm.-diameter ball. For ferrous metals, the load is usually 3000 kg. and it is usually held for a period of 15 seconds. For non-ferrous metals, 500 kg. load for 30 seconds is the most common standard. Recently the A.S.T.M. has recommended a 1500 kg. load between 80 and 160 B.H.N. After the impression has been made in this manner, its diameter is measured with a microscope. Standard tables of Brinell Hardness Numbers (B.H.N.) make it necessary to use the basic formula in testing.

The Brinell method is commonly used for testing castings, forgings, bars, etc. It can not be used satisfactorily for testing thin sheets or hard tool steels. Brinell tests are not recommended on material harder than 630 B.H.N. (*From new 8-page Bulletin B953, Steel City Testing Machine, Inc., 8817 Lyndon Ave., Detroit, Mich.*)

For this literature circle **414** on inquiry card.

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GALVANOMETER

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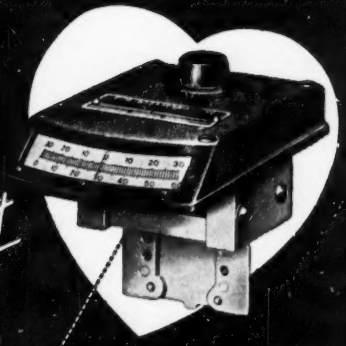

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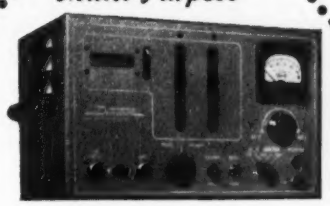

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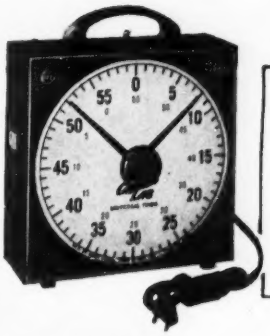

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MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 657.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Electronic Process Control. New 32-page illustrated Catalog 164 presents advantages of electronic process control; also describes new "American" line comprising miniature recorder, indicating and recording stations, controller, manual and valve positioners. —Amer. Ind. Inst. Div., Manning, Maxwell & Moore, Inc., Stratford, Conn.

Circle **401** on inquiry card.

Automation Economics. New 14-page booklet "How to Get the Most Out of Capital Expenditures" discusses economics of various production techniques.—The Cross Co., Detroit 7, Mich.

Circle **402** on inquiry card.

Furnace and Oven Controls. New 2-page illustrated Bulletin P1262 lists maker's furnace and oven control instruments carried in stock, including pyrometers, controllers, combustion safeguards, and thermocouples.—Bristol Co., Waterbury 20, Conn.

Circle **403** on inquiry card.

Process Instrumentation. New 12-page illustrated Bulletin 231-A lists features, types of instruments, descriptions, applications and circuit diagrams of maker's electronic instruments for temperature, pressure, flow, etc.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Circle **404** on inquiry card.

Combustion Control. New 24-page illustrated Bulletin 1023 describes typical installations of maker's air-operated controls on oil-fired, gas-fired and oil, gas, and coal fired boilers. Includes principles and installations.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Circle **405** on inquiry card.

Industrial Instrumentation. New 48-page illustrated issue (Vol. 7, No. 2) of "Instrumentation" features articles on graphic panels in washer lines of pulp and paper mill, instrumentation in penicillin production, furnace temperature control, and instrumentation of first privately owned nuclear reactor.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **406** on inquiry card.

Industrial Control. New 4-page illustrated issue of "Industrial Control News," (Vol. 2, No. 5) describes typical applications of maker's industrial control devices for automatic gas-tank switchover, ore feed rate control, etc. —Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **407** on inquiry card.

Optical-glass Instrumentation. New 4-page illustrated issue (Vol. 14, No. 1) of "Wheelco Comments" features articles on temperature control in annealing of optical glass and electrical control of anodizing process.—Barber-Colman Co., Rockford, Ill.

Circle **408** on inquiry card.

Medical, Food Instrumentation. New 28-page illustrated issue (Vol. 6, No. 3) of "Technology" features articles on Dextran, blood plasma substitute, supersonic wind tunnel construction, and cascade control systems, including description of maker's instruments for pressure and temperature control as applied to processes featured.—Taylor Instrument Cos., Rochester 1, N. Y.

Circle **409** on inquiry card.

Miniature Control Instruments. New 4-page illustrated Bulletin 109 describes maker's "Mini-line" miniature indicators, selector valves, and relays for control panel installation. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Circle **410** on inquiry card.

Batch Controller. New 4-page technical report, TI 29-B-52a, explains "Stabilog" controller for preventing "overshoot" during batch start-ups. Diagrams show instrument circuitry and comparative responses.—The Foxboro Co., Foxboro, Mass.

Circle **411** on inquiry card.

Position Transmitters. New 20-page illustrated bulletin gives principle of torque transmission and voltage indication, and description, features and dimensional drawings of maker's "Telesyn" generators and motors, differential generators and motors, and control transformers.—Ford Instrument Co., 31-10 Thomson Ave., Long Island City, N. Y.

Circle **412** on inquiry card.

Combustion Control. New 8-page illustrated Bulletin R-10 gives account of salt-manufacturer's exposed steam generator featuring air-flow and steam-flow compensated combustion control handling load swings up to 80,000 lb. per hour at 85 per cent efficiency.—Hays Corp., Michigan City, Ind.

Circle **413** on inquiry card.

Filling Scales. New 2-page illustrated bulletin presents maker's "Model 1000G" gross weight filling scale and "1000N" net weight filling scale.—Thayer Scale and Engineering Corp., E. Water St., Rockland, Mass.

Circle **414** on inquiry card.

Mechanical Remote Control. New 16-page illustrated Bulletin 500 describes applications and components of maker's mechanical controls, linkages, and mechanisms.—Teleflex, Inc., N. Wales, Pa.

Circle **415** on inquiry card.

Servomechanisms. New 4-page illustrated Bulletin MK-1-5000 covers manufacturer's precision instruments, hardware, equipment and systems and lists qualifications and experience of company's executives.—Mark Instrument Co., Inc., 613 Wilshire Blvd., Santa Monica, Calif.

Circle **416** on inquiry card.

VALVES

Diaphragm Motor Valves. New 4-page illustrated Specification Sheet 410-2 presents features, application, construction, and specifications of maker's Series "800" Saunders diaphragm motor valves.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **417** on inquiry card.

Valves. Four new bulletins describe several of maker's valves. Bul. 8300 presents 3-way solenoid valve; Bul. 8035 covers pressure-operated manual reset valve; Bul. 8336 on solenoid pilot-controlled valve; Buls. 8268, 8269 describe packless 2-way valves.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **418** on inquiry card.

Solenoid Valves. New 4-page illustrated Bulletin 500A describes maker's complete line of solenoid valves for automatic or remote control of steam, air, gas, or liquid flow.—J. D. Gould Co., 730 E. Washington St., Indianapolis, Ind.

Circle **419** on inquiry card.

Solenoid Valves. New 6-page illustrated Bulletin RS111 presents construction, dimensions, and applications of maker's new Model "73" solenoid valve.—A-P Controls Corp., 2450 N. 32 St., Milwaukee, Wis.

Circle **420** on inquiry card.

Refrigeration Valves, Filters, Driers. New 12-page illustrated catalog provides specifications, charts, and data for maker's line of valves, filters and driers for air conditioning and refrigerating industries.—A-P Controls Corp., Milwaukee 45, Wis.

Circle **421** on inquiry card.

Ammonia Valves. New 2-page illustrated bulletin describes maker's line of ammonia valves and fittings.—Henry Valve Co., 3215 North Ave., Melrose Park, Ill.

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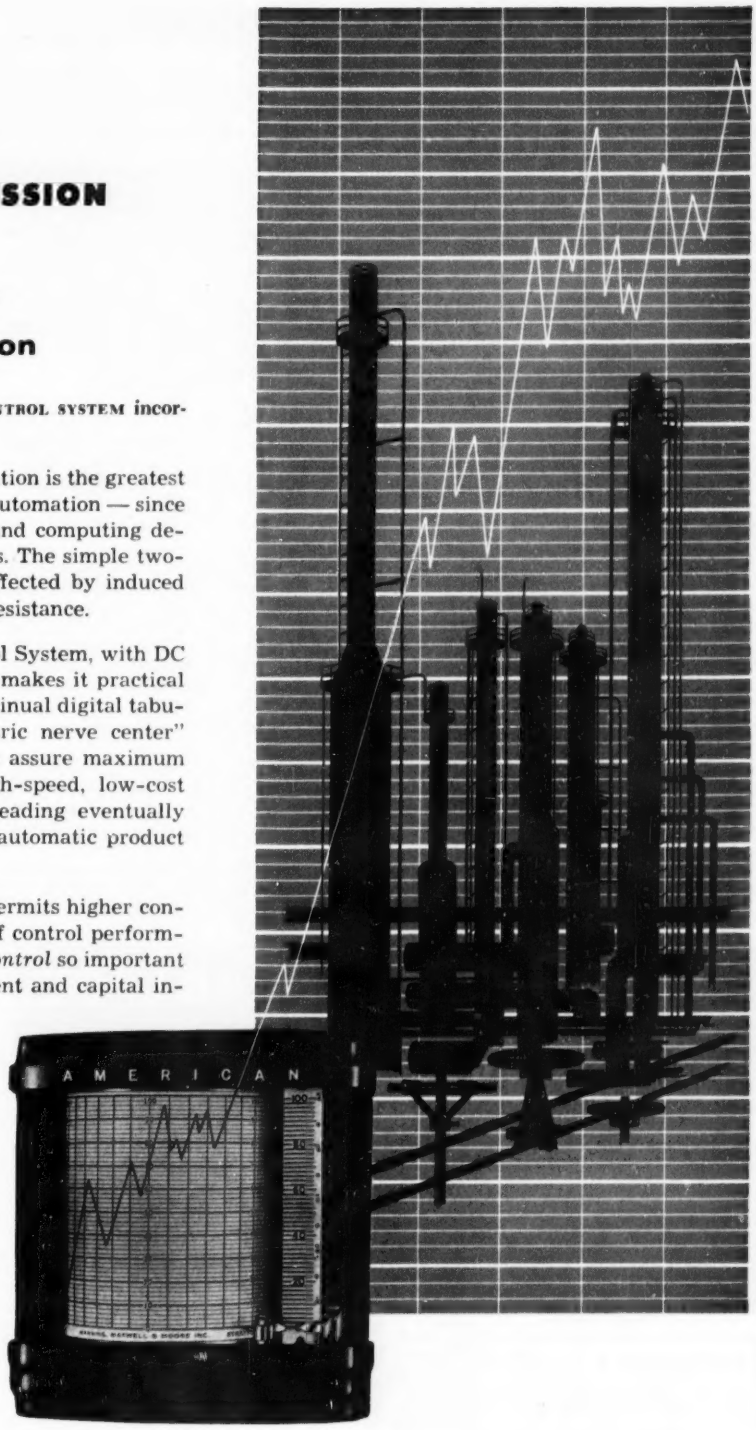

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For more information circle **125** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Motor Operators. New 8-page illustrated Bulletin 414-1 describes maker's "Air-O-Motor" pneumatic motor operators of spring and springless types.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **423** on inquiry card.

Butterfly Valves. New 12-page illustrated Bulletin 1701 contains specifications of maker's "Continental" butterfly valve bodies and "Series 800" diaphragm motor operators plus tables of allowable pressure differentials.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **424** on inquiry card.

Freon Valves. New 4-page Bulletin 1010 pictures and describes complete line of freon valves and accessories for refrigeration and air conditioning equipment.—Henry Valve Co., 3215 North Ave., Melrose Park, Ill.

Circle **425** on inquiry card.

Compressor Valves. New 2-page illustrated Bulletin 509-D presents maker's "Airchek" valve for compressor installation.—Pennsylvania Pump & Compressor Co., Easton, Pa.

Circle **426** on inquiry card.

TEMPERATURE

Temperature, Pressure, Testing. New 68-page illustrated Catalog GEC-1016A gives descriptions, specifications, and features of maker's large line of instruments for laboratory and production testing. Includes high-voltage testers, materials testing, chemical analysis instruments, temperature, pressure, radiation instruments, etc.—General Electric Co., Schenectady 5, N. Y.

Circle **427** on inquiry card.

Thermistors. New 54-page thermistor Manual No. TH-13 presents principles, operation, typical applications, and specifications for maker's thermally sensitive resistors (Thermistors). Include static and dynamic characteristics and use in temperature compensation, flow measurement, pressure measurement, time delay, etc.—Carboloy Dept., GE, Detroit 32, Mich.

Circle **428** on inquiry card.

Heat Transfer Coils. New 3-page illustrated Bulletin 8310 B1 presents considerations in selection of dual heat-transfer coils to condense steam.—Parker Appliance Co., 17325 Euclid Ave., Cleveland, Ohio.

Circle **429** on inquiry card.

Pipeline Heaters. New 8-page illustrated Bulletin GEA-5095A describes application of maker's "Calrod" tubular heaters for pipelines.—Includes chart showing heat losses of vertical, solid, smooth surface of various metals.—General Electric Co., Schenectady 5, N. Y.

Circle **430** on inquiry card.

Bimetal Thermostats. New 2-page illustrated Bulletin L-9070 gives principle, applications, ratings, and construction of maker's semi-enclosed and hermetically sealed "Stemco Type A" bimetallic thermostats.—Stevens Mfg. Co., Inc., Mansfield, Ohio.

Circle **431** on inquiry card.

Thermistors. New 28-page illustrated issue (Vol. 6, No. 1) of "Scientific Apparatus and Methods" discusses thermistor-actuated temperature regulating "Thermonitor," principles, plus catalog section covering laboratory apparatus.—E. H. Sargent & Co., 4647 W. Foster Ave., Chicago, Ill.

Circle **432** on inquiry card.

Thermometers, Hydrometers. New 36-page illustrated catalog lists distributor's line of hydrometers and thermometers plus temperature conversion table.—Emil Greiner Co., 20-26 N. Moore St., New York, N. Y.

Circle **433** on inquiry card.

Indicating Temperature Transmitter. New 4-page illustrated Catalog 1022 describes maker's indicating temperature transmitter with dial-type thermometer and pneumatic transmitter.—Penn Industrial Instrument Corp., 4110 Haverford Ave., Phila., Pa.

Circle **434** on inquiry card.

Temperature Cabinets. New 2-page illustrated Bulletin 109-101 covers features, temperature-humidity ranges and specifications of maker's new full-range humidity temperature test cabinet.—Hudson Bay Div., Refrigeration Systems, Inc., 646 Washington Blvd., Chicago, Ill.

Circle **435** on inquiry card.

Electric Heat. New 4-page Issue No. 52 of "Chromalox News" illustrates and describes applications of maker's radiant electric heating units in various industries.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh, Pa.

Circle **436** on inquiry card.

Electric Heat. New 32-page illustrated Bulletin F1550 lists 101 ways to apply electric heat to air, gases, machine parts, process equipment, and liquids.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

Circle **437** on inquiry card.

Multicell Heaters. New 1-page preliminary information bulletin gives description and specifications of maker's new multicell heater which prevents crossmigration of volatiles occurring in conventional ovens.—G. F. Bush Associates, Box 175, Princeton, N. J.

Circle **438** on inquiry card.

PRESSURE

Differential-pressure Transmitters. New 4-page Bulletin A-707-A presents features, description, operation, adjustments and components of maker's new "Type D2T" differential-pressure transmitters.—Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

Circle **439** on inquiry card.

Vacuum Coater. New 2-page illustrated Data Sheet 2-28 provides features and specifications of maker's 30-inch vacuum coater "Type LC1-30."—Consolidated Vacuum Corp., Rochester 3, N. Y.

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FLOW

Mechanical Flowmeter. New 4-page illustrated Catalog 1027 presents principle, capacities, pressures, construction, and maintenance of maker's tilting U-tube mechanical flowmeter.—Penn Industrial Instrument Corp., 4110 Haverford Ave., Phila., Pa.
Circle **441** on inquiry card.

Integrating Flowmeter. New 4-page (Vol. 3, No. 2) issue of "The FP Ratonews" presents illustrated articles on applications of maker's flowmeters in batch processing, and low temperature lubrication.—Fischer & Porter Co., Hatboro, Penna.
Circle **442** on inquiry card.

Signal Transmitter. New 4-page illustrated Bulletin 9653 gives description, operation, and schematic diagram of maker's pneumatic signal transmitter designed for use with maker's ring-balance meter.—Hagan Corp., Pittsburgh 30, Pa.
Circle **443** on inquiry card.

Orifice Meters. New 8-page Bulletin 56-B pictures maker's "Model 700" differential-pressure meter unit for recorders, indicators, controllers, and transmitters. Also describes maker's recorder and indicator.—Industrial Instrument Corp., P. O. Box 1909, Odessa, Tex.
Circle **444** on inquiry card.

Orifice Plates. New 4-page Bulletin 54-C presents data on maker's machine-cut handle type orifice plates, also plates for orifice fittings.—Industrial Instrument Corp., P. O. Box 1909, Odessa, Tex.
Circle **445** on inquiry card.

Fuel Flowmeter. New 4-page illustrated Bulletin 2500 describes performance, construction and applications of maker's precision positive-type flowmeter with accuracy to 0.01 gal.—Rhodes Lewis Co., 6151 W. 98 St., Los Angeles 4, Calif.
Circle **446** on inquiry card.

PUMPS

Controlled-volume Pump. New 24-page illustrated Bulletin 440 discusses features of "Pulsafeeder" diaphragm-type pump which also functions as chemical feeder, meter, filling machine, proportioner, and sampler. Manual or automatic types.—Lapp Insulator Co., Inc., Process Equip. Div., LeRoy, N. Y.
Circle **447** on inquiry card.

Controlled-volume Pump. New 2-page illustrated Bulletin 1153-A lists design features and capacity and pressure ranges of maker's new high-pressure and high-capacity controlled-volume pumps.—Milton Roy Co., Station L, 1300 E. Mermaid Lane, Phila., Pa.
Circle **448** on inquiry card.

Chemical Feed Pump. New 4-page Bulletin PM 20 covers maker's "Model S" heavy-duty, positive-displacement diaphragm-type feed pump for pumping small amounts of chemical solution.—Precision Machine Co., 8 Walnut St., Somerville, Mass.
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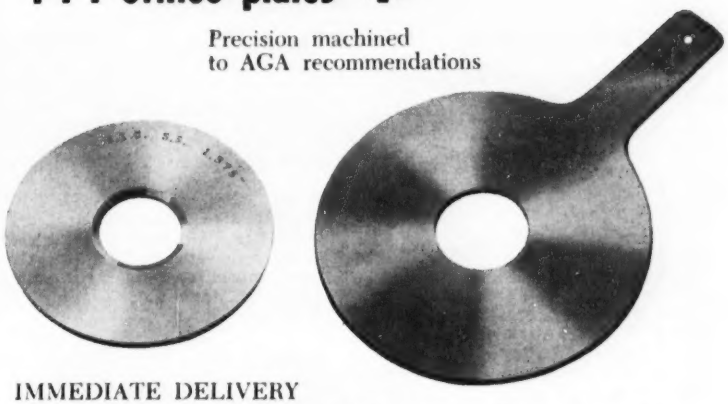

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3	2.00	2.70	1.50
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8	3.90	7.10	2.50
10	4.50	10.30	2.50
12	4.90	13.50	2.50
14	5.10	16.20	2.50
16	6.00	19.20	4.00

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Size	Chrome-Moly Steel	Stainless Steel Type 302 or 304	Additional Charge for Boring
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2	3.60	4.80	1.50
3	4.35	5.60	1.50
4	4.80	6.35	1.50
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NEW LITERATURE

RECORDING

Recording Oscillograph. New 16-page illustrated Bulletin CEC-1500C describes maker's new "Type 5-114" multi-channel recording oscillograph, including features, components, specifications, and accessories.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **450** on inquiry card.

Oscillographic Recorders. New 1-page illustrated bulletin describes features of maker's "150 series" oscillographic recorders with plug-in components.—Sanborn Co., Indus. Div., 195 Massachusetts Ave., Cambridge, Mass.

Circle **451** on inquiry card.

Oscillographic Recording. New 8-page illustrated issue (Vol. 1, No. 3) of "The Right Angle" features articles on differential input circuits and maker's new "150 Series" oscillographic recording systems.—Sanborn Co., Cambridge 39, Mass.

Circle **452** on inquiry card.

FORCE

Dynamometers. New 4-page illustrated bulletin describes "Dyna-Chek" dynamometers for determining torque, speed, and hp.-output of electric motors of 2 hp. and less.—Mission-Western Engineers, Inc., 132 W. Colorado, Pasadena 1, Calif.

Circle **453** on inquiry card.

Impact Machines. New 4-page illustrated Bulletin 4211 lists design features and specifications of maker's "Sonntag" impact machines for metals and plastics.—Baldwin-Lima-Hamilton Corp., Testing Equipment Dept., Phila. 42, Pa.

Circle **454** on inquiry card.

Strain. New 2-page illustrated Data Sheet 10.0-16 presents maker's electronic recorder applied to stress-strain measurement.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **455** on inquiry card.

GAGING

Pneumatic Dimensional Gages. New 24-page illustrated bulletin presents "Preview of Pneumatic Dimensional Gages" as given at the International Conference on Engineering Dimensional Metrology, England, 1953. Includes machine-tool application and automation.—Sheffield Corp., Dayton 1, Ohio.

Circle **456** on inquiry card.

Calipers, Micrometers. New 40-page illustrated Catalog 153 describes distributor's line of "Etalon" measuring instruments including vernier calipers, depth gages, bevel protractor, micrometers, and levels.—Alina Corp., 401 Broadway, New York, N. Y.

Circle **457** on inquiry card.

Indicator Gage. New 1-page illustrated bulletin lists features of distributor's large-capacity Swiss-made indicator "77" micrometer gage graduated in 0.0001 in.—Alina Corp., 401 Broadway, New York, N. Y.

Circle **458** on inquiry card.

Optical Comparator. New 12-page illustrated bulletin describes maker's "Model R-300" optical comparator, its components, dimensions, and specifications.—Portman Instrument Co., Town Dock Rd., N. Rochelle, N. Y.

Circle **459** on inquiry card.

Projector-Comparator. New 8-page illustrated Catalog OFG-200 includes operation, description, and specifications of maker's Model "OFG-200" optical form grinder projector-comparator.—Portman Instrument Co., Inc., Town Dock Rd., New Rochelle, N. Y.

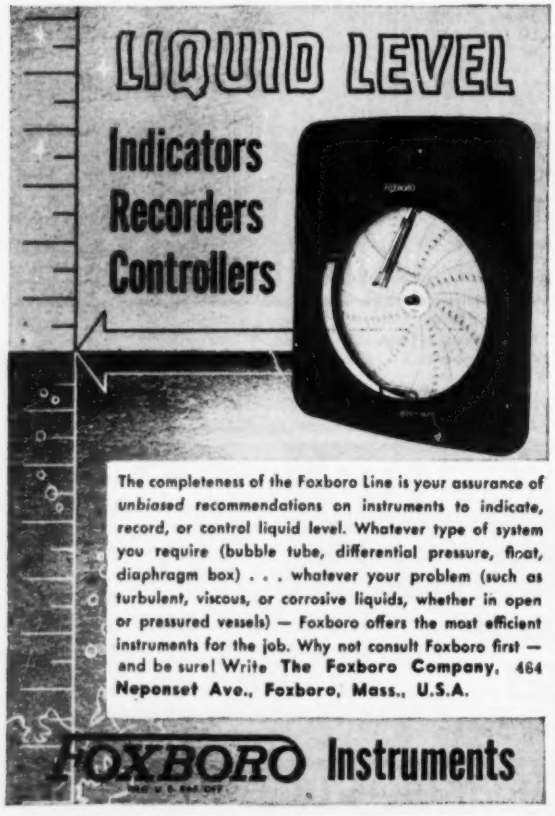
Circle **460** on inquiry card.

Precision Gages. New 2-page supplement illustrates and describes "Toolmakers" vernier caliper and height gage; also vernier depth gages, straight edges, and steel squares.—George Scherr Co., 200 Lafayette St., New York 12, N. Y.

Circle **461** on inquiry card.

MOTION, VIBRATION

Accelerometers, Transformers. New 8-page illustrated bulletin describes linear and angular accelerometers, linear and rotary variable differential transformers, pressure transducers,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and rotary accelerators.—Schaevitz Engineering, P. O. Box 505, Camden, N. J.

Circle **462** on inquiry card.

Vibration Isolators. New 4-page illustrated Bulletin 537 covers features, performance characteristics and dimensions of maker's "Series 262 and 633" vibration isolators.—Barry Corp., Watertown, Mass.

Circle **463** on inquiry card.

Electric Tachometer. New 16-page illustrated Bulletin 1153 gives description, technical data and components of maker's electric tachometer, including portable speed recorder, d-c. tachometer generator, coupling, and indicating instrument.—Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.

Circle **464** on inquiry card.

Vibration, Acceleration Recorders. New bulletins cover distributor's "Askania" two-reed frequency meter, inductive dynamic measuring device with carrier frequency, and brake-testing recorder.—European Products Importing Co., Inc., 154 Nassau St., New York, N. Y.

Circle **465** on inquiry card.

LEVEL

Bin Level Indicators. New 20-page illustrated catalog describes maker's pressure-actuated bin level indicators, installation, and aerator unit for introducing low-pressure air into granulated materials to maintain fluid characteristics.—Bin-Dicator Co., 13946 Kercheval Ave., Detroit, Mich.

Circle **466** on inquiry card.

RADIOACTIVITY

Radiation Instruments. New 20-page illustrated catalog 3017-A contains specifications and features of maker's medical X-ray control equipment, personnel dosimeters, health survey and isotope laboratory instruments and accessories.—Victoreen Instrument Co., 5806 Hough Ave., Cleveland, Ohio.

Circle **467** on inquiry card.

Nuclear Instruments. New 20-page illustrated bulletin lists maker's line of instruments and accessories for detection and measurement of radioactivity, including counter tube shields, protective, transporting and handling equipment and timing devices.—El-Tronics, Inc., Fifth & Noble Sts., Phila., Pa.

Circle **468** on inquiry card.

MOISTURE

Paper Moisture Regulation. New 8-page illustrated bulletin discusses measuring and regulating moisture, basis-weight and caliper in the pulp and paper industry.—Hygrotester Inc., 101 Henry St., Brooklyn 1, N. Y.

Circle **469** on inquiry card.

Moisture Meter. New 4-page illustrated bulletin presents procedure, performance, and comparative ratings

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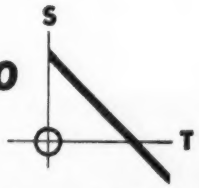

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Diehl Number: FPE 25-79-1
10 Watts Maximum Output
115 Volts Main Phase
115 Volts Control Phase
2 Poles
2 Phase
12.5 oz.-in. Locked Torque
23.0 oz.-in. Torque at minus 3000 R.P.M.
.125 oz.-in.^{2} Moment of Inertia
1.6 lbs. in Weight
38,600 Radians per Second^2 Theoretical Acceleration

This newly designed Diehl "HI-AC-CEL" Servo Motor affords high response and is suitable for a broad range of military and industrial servo-mechanism applications.

FEATURES:

1. Cogging (Slot effect) is Negligible
2. No Single-Phasing
3. Speed-Torque curve extends into the negative speed range at approximately the same slope.

Diehl "HI-AC-CEL" Servo Motors are obtainable in ratings from 5 to 25 watts output with standard 115 volt control phase windings and also with high impedance control phase windings. All ratings can be furnished with either A.C. or D.C. integrally mounted tachometer generators.

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Atlanta Baltimore Boston Chicago Detroit New York Philadelphia Worcester

For more information circle **130** on inquiry card.

NEW LITERATURE

of maker's "Olivo" moisture meter. —Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.

Circle **470** on inquiry card.

COMPUTING

Analog Computer. New 2-page bulletin "Model MK" analog instrument for computing applications requiring up to 4 operational amplifiers.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **471** on inquiry card.

Electrical Resolvers. New 6-page illustrated Bulletin R1-11 covers function, specifications, technical data of maker's electrical resolvers for vector-solving applications.—Ford Instrument Co., 21-10 Thomas Ave., Long Island City, N. Y.

Circle **472** on inquiry card.

Electronic Data Processing. New 32-page illustrated Bulletin 52-9461 describes analog and digital computers, functions of input, storage, arithmetic, control and output components, and devices for storage of information.—International Business Machines Corp., 590 Madison Ave., New York, N. Y.

Circle **473** on inquiry card.

Analog-digital Converter. New 6-page bulletin introduces maker's analog-to-digital converter. Other 6-page bulletin describes operation and typical data-handling system utilizing maker's converter.—J. B. Rea Co., Inc., 1723 Cloverleaf Blvd., Santa Monica, Calif.

Circle **474** on inquiry card.

COUNTING

Magnetic Impulse Counter. New 4-page illustrated bulletin and supplementary data sheet describe selector switch for use in control, computer design, telephone, telemetering, and other fields.—Kellogg Switchboard & Supply Co., 79 W. Monroe St., Chicago 3, Ill.

Circle **475** on inquiry card.

Electric Counting Device. New 2-page illustrated Bulletin 14PA1 presents maker's revolution-counting device for ready-mixed concrete trucks. —Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **476** on inquiry card.

ANALYTICAL

Analytical, Lab Instruments. New 8-page illustrated Bulletin ENT(39) 1080-154 covers maker's "Electro-Chemograph" installation for control of type metal alloys, oxygen analyzer, underground laboratory for care of diffraction grating, thermocouple bath pyrometers, rotary kiln, and lab applications of multiple-point controller. —Leeds & Northrup Co., 4907 Stenton Ave., Phila., Pa.

Circle **477** on inquiry card.

Spectrography. New 8-page bulletin describes optical "Quantometers" for chemical analysis of steels, aluminum, copper, titanium, and other metals; wherever spectrographic methods are applicable.—Applied Research Laboratories, 3717 Park Pl., Glendale 8, Calif.

Circle **478** on inquiry card.

Furnace-gas Analysis. New 1-page Bulletin AD-609 describes method and equipment for measuring and controlling oxygen in metallurgical furnaces. —Arnold O. Beckman, Inc., 1020 Mission St., S. Pasadena, Calif.

Circle **479** on inquiry card.

pH Control. New 8-page illustrated Bulletin 13 features articles on pH recording in dental cavity research, photomultiplier for spectrophotometer, hospital use of flame analysis, new industrial pH meter, and spectrophotometry in toxicological investigation. —Beckman Instruments, Inc., S. Pasadena, Calif.

Circle **480** on inquiry card.

Comparator-Microdensitometer. New 2-page illustrated Bulletin 190-53 illustrates and describes maker's comparator-microdensitometer for evaluation of spectrographic plates.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

Circle **481** on inquiry card.

Electron Microscope. New 4-page illustrated Bulletin WA4-D1 presents features of electronic optical system, photographic arrangement, and appli-

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Sub-miniature E4

This Electro-Snap Sub-Miniature Basic Switch handles 5 amps at 125/250 v. AC, yet has a plastic case no thicker than a lead pencil, less than 27/32" long, 23/64" high. Low operating force and small movement differential make it ideal for "feather touch" devices such as diaphragms, bimetal elements and other precision control applications. Since snap action is independent of speed of actuation, switch performs equally well when actuated by slow or fast moving cams, etc. The patented snap-action "S"pring compression member equalizes the stress on the switch springs which eliminates early fatigue commonly caused by concentrated stress on only one part of the spring. Sturdy terminals at bottom permit wiring without increasing length dimension. Available in normally open or closed single-pole, and single-pole, double-throw models. Toggle, push button and leaf spring actuators available. Custom-made rotary actuated multiple mountings and hermetically sealed housings also available on special order. Write for Data Sheet EG-4.

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cation of maker's "Type 11980" electron microscope.—North American Philips Co., Inc., Mount Vernon, N. Y.

Circle **482** on inquiry card.

Smoke Photometer. New 4-page illustrated Bulletin JM-1000 presents principle of operation, features, and applications of distributor's "Sinclair-Phoenix" forward-scattering smoke photometer.—Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila., Pa.

Circle **483** on inquiry card.

Hydrogen Analyzer. New 4-page illustrated Bulletin 301 describes features and operation of maker's new hydrogen analyzer for continuous analysis, control, and recording of molecular hydrogen.—Taller & Cooper, Inc., 75 Front St., Brooklyn, N. Y.

Circle **484** on inquiry card.

Gas Analyzer. New 4-page illustrated bulletin presents description and specifications of maker's new "Portoco" carbon-monoxide detector. —Taller & Cooper, Inc., 75 Front St., Brooklyn, N. Y.

Circle **485** on inquiry card.

Spectrophotometry. New pocket-size card FC-47 carries emission spectra for 36 typical elements determinable by spectrophotometry.—Beckman Instruments, Inc., South Pasadena 1, Calif.

Circle **486** on inquiry card.

LAB APPARATUS

Laboratory Instruments. New 4-page issue (Vol. 1, No. 2) of "Newsletter" features descriptions of portable industrial cabinet ovens, colorimeter, interchemical wet film thickness gage, viscosimeter, rubber hardness tester, explosion-proof laboratory mixers.—Gardner Lab., Inc., Bethesda 14, Md.

Circle **487** on inquiry card.

Research Instrumentation. New 8-page illustrated Bulletin R-12 describes air force parachute research involving maker's free-fall missile and supersonic test sled with recording instruments and cameras.—Cook Research Labs., Div., of Cook Electric Co., 8100 Monticello Ave., Skokie, Ill.

Circle **488** on inquiry card.

Glassware Washers. New 4- and 20-page bulletins describe maker's laboratory glassware washers and accessories, as well as variations of washers for animal cages, special glassware and feeding equipment.—Heinicke Instruments, 2035 Harding St., Hollywood, Fla.

Circle **489** on inquiry card.

Scientific Glassware. New 8-page illustrated bulletin covers maker's indicating thermocouple gages, ionization gages, precision-bore glass tubing and metalized glass.—George E. Fredericks Co., Bethayres, Pa.

Circle **490** on inquiry card.

Laboratory Apparatus. New 16-page illustrated Bulletin 700 covers distributor's laboratory apparatus, including attrition mill, proportional

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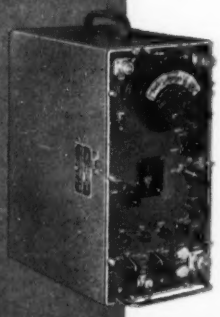

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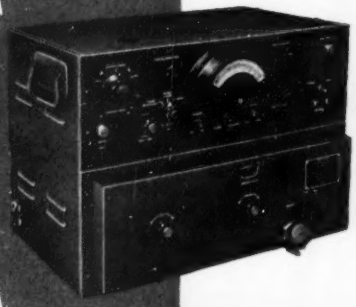

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NEW LITERATURE

pump, autoclave, muller, test cabinets, miniature refrigerators, and stainless steel beakers.—Andrew Technical Service, 6972 N. Clark St., Chicago, Ill.

Circle **491** on inquiry card.

Analytical Balance. New 8-page bulletin describes and illustrates new "Gram-atic" direct-reading balance which eliminates handling weights, and features speedy operation—"dial weight in 20 seconds."—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle **492** on inquiry card.

Automatic Fraction Collector. New 1-page illustrated bulletin describes maker's "Model 230" automatic fraction collector for both time and drop counting in column chromatography. —Packard Instrument Co., P.O. Box 428, La Grange, Ill.

Circle **493** on inquiry card.

SERVOS, MOTORS

Synchros, Servos, Resolvers. New 4-page illustrated catalog lists typical characteristics of maker's servo motors, synchro control transformers, receivers, resolvers and transmitters, and induction motors.—Ketay Mfg. Corp., 555 Broadway, New York, N. Y.

Circle **494** on inquiry card.

Frac-hp. Motors. New 12-page illustrated catalog covers construction and performance data on maker's subfractional-hp. motors of universal, direct-current and induction types. Includes motors for special applications.—Howard Industries, Inc., Racine, Wis.

Circle **495** on inquiry card.

POWER SUPPLIES

Regulated Power Supplies. New 4-page illustrated issue (Vol. 1, No. 1) of "Power Supply Newsletter" gives specifications of maker's regulated power supplies.—Lambda Electronics Corp., 103 Northern Blvd., Corona, N. Y.

Circle **496** on inquiry card.

Meter Calibrator. D.C. Reference. New 2-page illustrated bulletin gives specifications and applications of maker's meter calibrating unit providing standard d-c. reference.—Kalbfell Laboratories Inc., 1090 Morena Blvd., San Diego, Calif.

Circle **497** on inquiry card.

Power Supply. New illustrated 2-page bulletin describes "Model 2" 300-vdc. regulated power supply. Presents features and other data. Describes maker's "custom services."—Eastgap Co., 285 Columbus Ave., Boston 16, Mass.

Circle **498** on inquiry card.

ELECTRONIC INSTRUMENTS

Pulse Circuits. New 2-page illustrated bulletin gives specifications of maker's "Model 110A" variable frequency unit, "Model 211" pulse-width control unit and "Model 300A" pulse-forming unit.—Electro-Pulse Inc., 11811 Major St., Culver City, Calif.

Circle **499** on inquiry card.

Circuit Loading Errors. New 1-page illustrated issue (Vol. 1, No. 2) of "Engineering Notes" discusses reduction of circuit loading errors by use of maker's "Phantom Repeater" decade amplifier.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **500** on inquiry card.

Comparison Bridge. New 8-page illustrated issue (Vol. 28, No. 9) of "Experimenter" describes new comparison-bridge production test instrument, Type "1604-B" and instruments displayed at Radio Engineering Show. —General Radio Co., Cambridge, Mass.

Circle **501** on inquiry card.

Resistance-capacitance Filter. New 4-page Bulletin 500 gives features, description, operation, and standard types of maker's "Series 500" twin-T resistance-capacitance filter networks. —White Instrument Laboratories, 203 Riverside Dr., Austin, Texas.

Circle **502** on inquiry card.

Dc.-Ac. Choppers. New 4-page Catalog 370 discusses uses and operation, and diagrams applications of redesigned line of 60-cycle choppers for operation at noise levels under 1 millivolt.—Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass.

Circle **503** on inquiry card.

Magnet Charger. New 2-page illustrated bulletin lists types and makes of instruments to which the maker's "Model 107" magnet charger can be adapted for service and repair of instrument magnets. 4-page supplement gives operating instructions for charger and special adapters.—Radio Frequency Laboratories, Inc., Boonton, N. J.

Circle **504** on inquiry card.

Coaxial Cable Noise. New 4-page illustrated issue of "Engineering News" (Vol. 7, No. 1) features article on new methods of measuring noise in low-noise cables, and presents maker's insulation testers, electronic organ, and chromate conversion.—American Phenolic Corp., 1830 South 54th Ave., Chicago, Ill.

Circle **505** on inquiry card.

Oscilloscopes. New 24-page illustrated Catalog 25410C presents description, and principles of operation of oscilloscopes, including maker's cathode ray oscilloscopes.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle **506** on inquiry card.

Panel Indicators. New 2-page illustrated Bulletins 112 and 120 present specifications and ranges and approximate resistance tables for maker's 1½-in. square and round watertight panel electrical indicators.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **507** on inquiry card.

High-resistance Measurement. New 1-page issue of "Engineering Notes" discusses two accurate ways to measure high resistance by use of maker's vacuum-tube electrometer and shunt, or with electrometer and low-leakage capacitor.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **508** on inquiry card.

Video Generator. New 4-page illustrated bulletin covers description, features, sample testing patterns and related adjustments, and technical characteristics of maker's "Model 650" video generator.—Hickok Electrical Instrument Co., 1054 Dupont Ave., Cleveland, Ohio.

Circle **509** on inquiry card.

Color-TV Testers. New 8-page illustrated bulletin covers maker's line of test equipment for color television and black and white television.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle **510** on inquiry card.

Phase Comparator. New 8-page illustrated bulletin lists characteristics, performance curves, dimensional drawings and description of maker's full-wave bridge comparator for use as modulator, demodulator or switch.—Sanders Associates, Inc., 137 Canal St., Nashua, N. H.

Circle **511** on inquiry card.

Oscillograph. New 12-page Bulletin 323-WP-12K illustrates and describes "Type 323" cathode-ray oscillograph with sensitivity from d.c. to 20 Mc.—Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **512** on inquiry card.

Signal Generators. New 4-page Bulletins 690J, 691J-154C and 695J-154 cover specifications and features of maker's new marker generator, heterodyned marker adder and sweep-alignment TV generators.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle **513** on inquiry card.

Microwave Impedance. New 8-page illustrated issue (Vol. 2, No. 3) of "PRD Reports" features summary article on precision measurements with slotted sections.—Polytechnic Research and Development Co., Inc., 55 Johnson St., Brooklyn, N. Y.

Circle **514** on inquiry card.

Shielded Enclosures. New 16-page illustrated bulletin, "Evaluating Shielded Enclosures," discusses major factors involved in shielded enclosure specifications, structural factors, air inlets, etc.—Ace Engineering & Mach. Co., 3644 N. Lawrence St., Phila., Pa.

Circle **515** on inquiry card.

Signal Generator. New 2-page brochure pictures and describes "Mega-Pix Sr." crystal-controlled TV picture-and-sound r-f. signal source with 24 separate crystals.—Kay Electric Co., 25 Maple Ave., Pine Brook, N. J.

Circle **516** on inquiry card.

Time Delay Generator. New 1-page specifications sheet presents technical data on maker's "Model A-5" time de-

A NEW APPROACH ON

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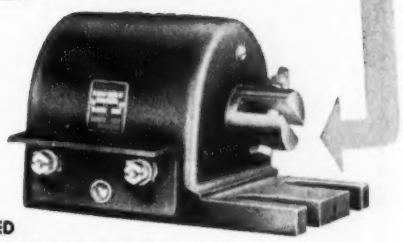

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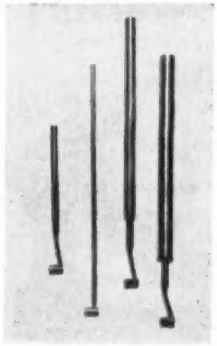

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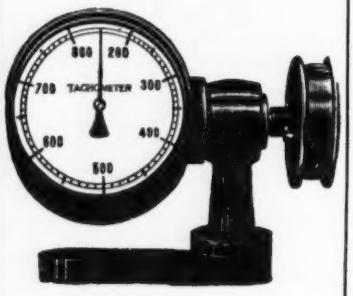

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For more information circle **141** on inquiry card.

NEW LITERATURE

lay generator.—Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.

Circle **517** on inquiry card.

Digital Voltmeters. Now 4-page Bulletin 12 lists models, description, and features of maker's digital voltmeters. —Non-Linear Systems, Inc., Del Mar, Calif.

Circle **518** on inquiry card.

Test Instruments. New 194-page illustrated Catalog 54 presents many lines of industrial and electrical test equipment available from distributor. Includes complete lines of Weston, Metron, Associated Research, Simpson, General Control, GE, Veeder-Root, Micro-Switch, and others.—Electro-Tech Equipment Co., 308 Canal St., New York, N. Y.

Circle **519** on inquiry card.

A-c. Voltmeter. New 4-page illustrated bulletin describes multi-range transfer volt-ammeter with accuracy 0.05 percent through range from 20 to 20,000 cps.—Charles Engelhard, Inc., 850 Passaic Ave., East Newark, N. J.

Circle **520** on inquiry card.

Time Delay Generator. New 2-page Bulletin R358 illustrates and describes "Model A-5" for generation of accurate and variable time intervals.—Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.

Circle **521** on inquiry card.

Audio Amplifier. New 2-page bulletin presents features and complete data on "Type AAM-1" dual-channel audio amplifier for audio and supersonic frequencies.—A.R.F. Products, Inc., 7627 Lake St., River Forest, Ill.

Circle **522** on inquiry card.

Deviation Meter. New 2-page bulletin pictures and describes "Model AR-1" FM demodulator and deviation meter for measuring deviation up to 1 Mc.—A.R.F. Products, Inc., 7627 Lake St., River Forest, Ill.

Circle **523** on inquiry card.

Crystal Calibrator. New 2-page bulletin describes "Model AFR-1" crystal calibrator and sampler.—A.R.F. Products, Inc., 7627 Lake St., River Forest, Ill.

Circle **524** on inquiry card.

RESISTORS, POTENTIOMETERS

Precision Potentiometers. New 4-page illustrated issue No. 5 of "Helinews" discusses function of pots in a remote-reading tank gage system. Also describes single-turn pots and improved T-series pot.—Helipot Corp., South Pasadena, Calif.

Circle **525** on inquiry card.

Potentiometer Noise. New 8-page Bulletin S 1002-2M-3/53 presents monograph, "Electrical Noise in Wire-Wound Potentiometers," describing kinds of noise, methods of measuring it, and sets up system of units in

which noise can be expressed.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **526** on inquiry card.

Ten-turn Potentiometer. New 2-page illustrated bulletin describes "Decadial Model B-1" ten-turn precision potentiometer with dial knob attached directly to shaft to eliminate backlash.—Ford Engineering Co., 129 East "A" St., Upland, Calif.

Circle **527** on inquiry card.

Helical Potentiometers. New 8-page Catalog 9 presents pictures, drawings, and complete data on "Multipot" line of precision helical-type potentiometers.—Ford Engineering Co., 129 East "A" St., Upland, Calif.

Circle **528** on inquiry card.

Rheostats, Resistors. New 2-page illustrated issue (Feb. 1954) of "Ohmite News" describes use of maker's rheostats and resistors in new radar power unit, and gives applications of maker's ceramic open-type tap switches, adjustable resistance units, and field rheostats.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.

Circle **529** on inquiry card.

Portable Potentiometer. New 2-page bulletin pictures and describes "Model HF1" potentiometer for laboratory and field use featuring single ten-turn dial to cover entire range.—Williamson Development Co., 317 Main St., West Concord, Mass.

Circle **530** on inquiry card.

Potentiometers. New 4-page Bulletin 162 and insert sheet cover mechanical and electrical properties and specifications of maker's "Types 162A, 200, and 300" single-turn linear and nonlinear potentiometers.—George Rattray & Co., Inc., 116-08 Myrtle Ave., Richmond Hill, N. Y.

Circle **531** on inquiry card.

Resistors, Components. New 24-page Catalog No. 54 presents complete data, drawings, and illustrations of maker's full line of controls, resistors, rheostats, regulators, attenuators, etc. —Clarostat Mfg. Co., Inc., Dover, N. H.

Circle **532** on inquiry card.

SWITCHES, RELAYS

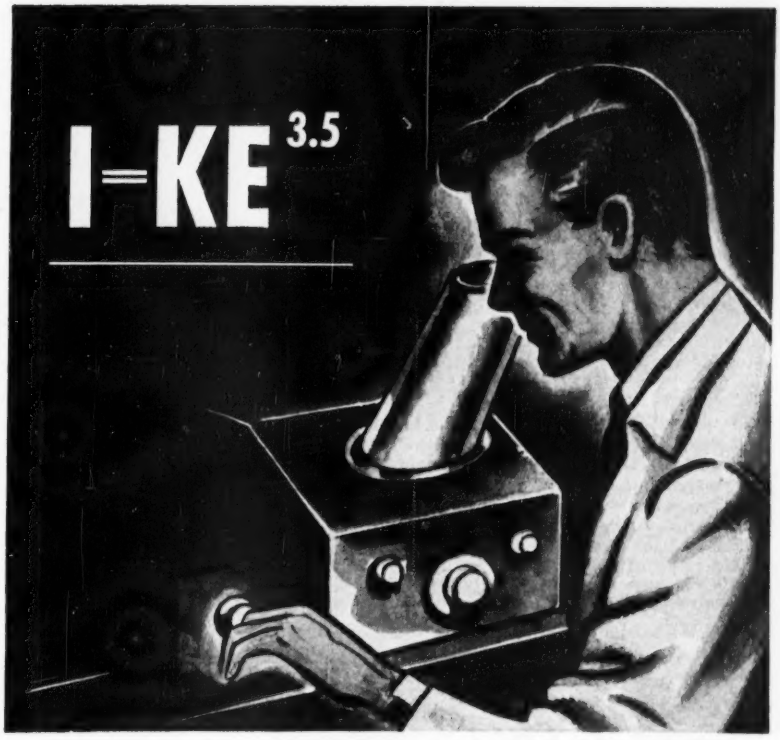
Switches. New 4-page illustrated Catalog 74 lists contact arrangement, terminals, characteristics, and electrical ratings of maker's "Type V3" postage-stamp-size snap-action switches and auxiliary actuators.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **533** on inquiry card.

Nonmagnetic Relay. New 2-page Bulletin Cdg 4775-5M is advance information sheet on maker's "Capaswitch" relay using electrostrictive capacitive element to transfer contacts.—Mullenbach Electrical Mfg. Co., 2300 E. 27 St., Los Angeles, Calif.

Circle **534** on inquiry card.

Miniature Switches. New 4-page illustrated Bulletin 84-117 covers typical miniature switch assemblies, including V 3 Line, toggle, hermetically



Problem: To hold I (light intensity) at a constant value when E (voltage) has random variation of ± 10%

There is obviously no solution to the problem as stated. It follows, then, that where voltage is as critical as in the above formula, untold man-hours of research, test, design, or production may be completely wasted unless E can be accurately controlled.

Whether E or its equivalent in any formula is AC (60-cycle or 400-cycle) or DC, Sorensen electronic regulating equipment is designed to make the results of your work more accurate and your time more fruitful. Instruments are available from stock to fit a very large variety of applications.

AC REGULATORS — Capacities from 150VA to 15KVA, regulation accuracy ±0.1% with good waveform. A precision model regulates to ±0.01% and has a capacity of 1000VA.

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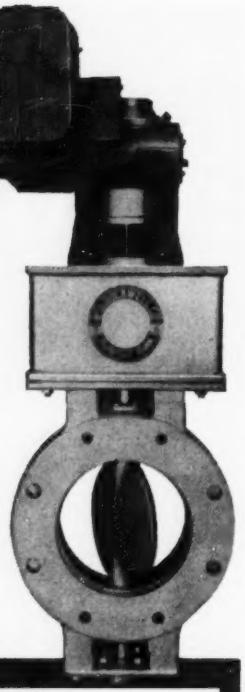

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Automatic Control—electric, air, hydraulic, float, solenoid, etc. Or manual control, if desired.
Pressures—to 300 p.s.i. and higher.
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We also manufacture wafer type butterfly valves; slide and gate valves; proportioning valves; swing check valves. Write for Catalog.

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Butterfly valve with outboard roller bearings, electric motor operator and auxiliary handwheel control, for high velocity air at 125 p.s.i. and temperatures from minus 20° to plus 200° F.

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2644 ELIOT STREET, FAIRFIELD, CONN.

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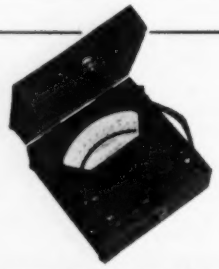

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MULTIMETERS and REGULAR METERS
AC and DC types, multiple ranges, accuracy—½ of 1%. 2 microamperes to 1 ampere DC. 2 milliamperes to 3 amperes AC.

ELECTROSTATIC VOLTMETERS
Ranges 100 V to 35,000 V, AC or DC. Resistance exceeds million megohms. Can measure static electricity.

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Now available, popular type RL11C, for radar and computor circuits — *write for new bulletin.*

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PRESSURE GAGES . . .

—must have a high degree of accuracy. They must be built to give long service. They must be easy to maintain.

In the Acragage you get these vital necessities, plus the Solid Front with full area blow out disc. If your gages are to be used on services where pulsation is the problem, the Acragage can be equipped with the Shockstop, the pulsation dampener that cannot plug and that never has to be cleaned.

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For more information circle **145** on inquiry card.

NEW LITERATURE

sealed and subminiature switches.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **535** on inquiry card.

Trip Control, Switches. New Data Sheets 80 and 85 describe automatic cycling and single stroke trip control; and splash proof switches. Information Sheet on Packet 14PA1 describes new switch controlled counting device for "ready mixed trucks". Preliminary Data Sheets P79, P86, and P87 cover environment-proof switch assemblies; rotary selector assemblies; and high-temperature basic switch.—Micro Switch, Freeport, Ill.

Circle **536** on inquiry card.

Snap-action Switches. New 36-page illustrated Catalog No. 98 presents complete data on maker's line of precision snap-action switches and actuators, including military approved models.—Acro-Mu Switch Div., Acro Mfg. Co., Columbus 16, Ohio.

Circle **537** on inquiry card.

Circuit Breakers. New 8-page booklet illustrates and describes four newest improvements in maker's "Stablok" circuit breaker design to improve operation under extreme conditions.—Federal Electric Products Co., 50 Paris St., Newark, N. J.

Circle **538** on inquiry card.

Machine-tool Limit Switches. New bulletins cover maker's machine-tool limit switches with 11 contact arrangements, including dimensions, description, applications, and construction.—Square D Co., 4041 N. Richards St., Milwaukee, Wis.

Circle **539** on inquiry card.

Miniature Relays. New 4-page illustrated bulletin lists general specifications and schematics of maker's new line of 22 types of dynamically and statically balanced 125G miniature relays.—S. H. Couch Co., Inc., North Quincy 71, Mass.

Circle **540** on inquiry card.

TRANSISTORS, TUBES

Transistors, Transformers. New 64-page issue (Vol. 57, No. 2) of "General Electric Review" presents illustrated articles on guided missiles, electromagnetic power transformer, mechanized magnet production, transistor applications, and others.—General Electric Co., Schenectady 5, N. Y.

Circle **541** on inquiry card.

Transistors. New 24-page illustrated Bulletin, "Transistors, Today and Tomorrow," covers history, use, features, types, manufacture, and future of transistors.—Radio Corp. of America, RCA Bldg., 30 Rockefeller Plaza, New York, N. Y.

Circle **542** on inquiry card.

Rectifiers and Diodes. New bulletins present maker's selenium power rectifiers, high-voltage selenium rectifiers, selenium diodes, germanium diodes, and miniature rectifiers.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle **543** on inquiry card.

Electron Tubes. New 12-page brochure lists types of electron tubes available from distributor; also pricing, inventories, and service.—State Labs, Inc., 649 Broadway, New York 12, N. Y.

Circle **544** on inquiry card.

Power Rectifiers. New 4-page illustrated catalog lists maker's line of selenium rectifiers, rectifier transformers, capacitors and chokes, d-c. panel meters, and "Powerstats."—Gates Electric Co., 65 W. Broadway, New York, N. Y.

Circle **545** on inquiry card.

ELECTRONIC COMPONENTS

Printed Circuits. New 2-page Catalog Sheet G-1 pictures and describes 7 and 9-pin glass-bonded mica printed circuit sockets adaptable to assembly methods.—Mycalex Corp. of America, Clifton Blvd., Clifton, N. J.

Circle **546** on inquiry card.

Electronic Parts, Equipment. New 4-page (Vol. 10, No. 1) issue of "Radio and Electronic News" pictures and describes maker's new equipment and components; features new short-wave radar system.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **547** on inquiry card.

Sockets. New 24-page illustrated Catalog L-154 presents maker's bracket-mounted sockets for small lamps, including descriptions and lamp types.—Dialight Corp., 58 Stewart Ave., Brooklyn, N. Y.

Circle **548** on inquiry card.

Capacitors. New 2-page illustrated Bulletin 525 presents maker's subminiature tantalum-foil electrolytic capacitors.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **549** on inquiry card.

Capacitors. New 4-page illustrated Catalog 1134 describes maker's line of tubular oil-filled capacitors.—Industrial Condenser Corp., Dept. IAP, 3243 N. California Ave., Chicago, Ill.

Circle **550** on inquiry card.

Printed-circuit Connectors. New 2-page illustrated bulletin gives design features, electrical and mechanical ratings and laboratory test data on maker's series "P-C" connectors for use with printed-circuit plates.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **551** on inquiry card.

Connectors. New 2-page Catalog 12 presents maker's subminiature "Series FHL" connectors; 2-page Bulletin 16C presents new "Series ME-z 16" easy-release power connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **552** on inquiry card.

Microwave Directional Couplers. New 6-page Bulletin T-2400, presents theory of operation, characteristics, and application suggestions on four basic types of directional couplers. Illustrates 12 typical couplers.—Airtron, Inc., Linden, N. J.

Circle **553** on inquiry card.

American Helicopter Co. XH-26 "Jet-Jeep"

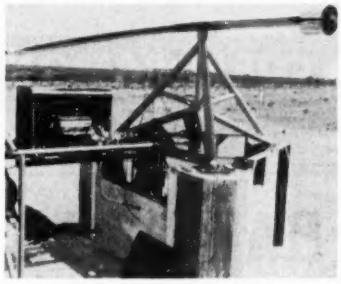
EMERY SOLVED THIS WEIGHING PROBLEM

FOR THE AMERICAN HELICOPTER CO., Mesa, Ariz.

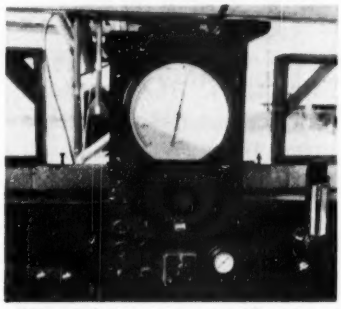
THE PROBLEM: Determine the thrust of rotor tip-mounted pulse-jet engines under simulated flight conditions.

THE SETUP: A single, counterweighted, main rotor blade with pulse-jet unit is mounted on a test stand. A Chrysler industrial engine, geared to rotate the blade under test, is mounted on a cradle suspended from two points on the centerline of its own drive shaft.

THE SOLUTION: Emery Closed Hydraulic Weighing System. An EC-30 Cell "weighs" the reactive torque developed between the Chrysler motor cradle and its support frame at any desired rotor speed. The industrial engine is then uncoupled from the rotor shaft, and the rotor turned by the pulse-jet unit at the same speed. The torque provided by the pulse-jet engine is the same (after correction for mechanical power transmission and other losses) as that required of the Chrysler engine to run the rotor at the given rate.



Pulse-Jet Rotor mounted on Test Stand



Emery Indicator at test control station

A 16 INCH, 0-1000 POUND Emery Bourdon Indicator is mounted with other instruments and controls at the operator's station beneath the test stand. The Emery indicator is calibrated in two-pound increments.

ACCURACY WAS PROVEN by American Helicopter Co. engineers, who found the Emery system provided thrust data whose error was less than 1%.

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WIDE RANGE of stock sizes of Emery Closed Hydraulic, Hydraulic Flow, and Pneumatic Cells permit precision measurement of 1 to 100,000 pounds. Also special sizes up to 10,000,000 pounds.

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THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

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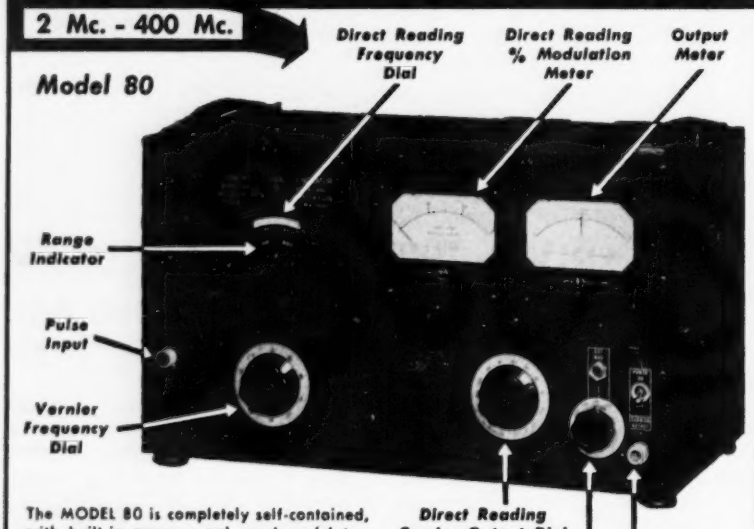
STANDARD SIGNAL GENERATOR

2 Mc. - 400 Mc.

Model 80



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For more information circle **149** on inquiry card.

NEW LITERATURE

Electronic Insulators. New 12-page illustrated Bulletin EC-1153 gives properties, features and ratings of "Chemelec" stand off and feed through insulators.—Fluorocarbon Products, Inc., Div. of U. S. Gasket Co., Camden 1, N. J.

Circle **554** on inquiry card.

Electronic Components. New 12-page illustrated catalog lists distributor's electronic components, optical and photo equipment, test equipment, and tools.—Radio Shack Corp., 167 Washington St., Boston, Mass.

Circle **555** on inquiry card.

Bushings and Terminals. New 4-page illustrated bulletin features "MIL-T-27" and special cans for hermetic seal bushings and terminals.—Heldor Mfg. Corp., 238 Lewis St., Paterson, N. J.

Circle **556** on inquiry card.

Microwave Components. New 12-page illustrated Bulletin 2-54-5M-WP describes components, equipment and typical microwave and "Multiplex" installations.—Collins Radio Co., Cedar Rapids, Iowa.

Circle **557** on inquiry card.

TUBING

Tubing. New 9-page Data Memorandum 7-2 covers properties, applications, and features of maker's seamless and "Weldrawn" beryllium-copper tubing.—Superior Tube Co., 1565 Germantown Ave., Norristown, Pa.

Circle **558** on inquiry card.

Armored Cable. New 4-page Bulletin G 91-9 gives features and installation of maker's flexible "Armortube" protected cable.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Circle **559** on inquiry card.

Tubing Protection. New 2-page illustrated Bulletin P-5312 describes new line of plastic plugs and caps for sealing openings and tube ends during shipping, maintenance, and storage.—S. S. White Plastics Div., 10 E. 40 St., New York, N. Y.

Circle **560** on inquiry card.

Plastic Tubing. New 4-page bulletin describes "Cobon" transparent flexible plastic tubing for laboratory, medical, and industrial use. Lists sizes; table gives chemical resistance data.—Couse & Bolten Co., 42-46 Lafayette St., Newark 2, N. J.

Circle **561** on inquiry card.

FABRICATION

Drilling Machine. New 4-page illustrated Bulletin AM-54 provides description, dimensions and specifications of maker's "A-M" super sensitive small hole drilling machine.—Hamilton Tool Co., 902 Hanover St., Hamilton, Ohio.

Circle **562** on inquiry card.

Drafting Instruments. New 24-page illustrated bulletin describes maker's

drafting templates for axonometric, isometric and dimetric drawings and lettering and symbol templates.—John R. Cassell Co., Inc., 110 W. 42nd St., New York, N. Y.

Circle **563** on inquiry card.

Dies. New 4-page Catalog D-134 lists specifications and prices of maker's standard dies.—Carboloy Dept., General Electric Co., 11177 E. 8 Mile Rd., Detroit, Mich.

Circle **564** on inquiry card.

Cold Riveting Hammer. New 4-page illustrated bulletin lists general specifications of maker's hammers for cold riveting operations.—High Speed Hammer Co., Inc., 313 Norton St., Rochester, N. Y.

Circle **565** on inquiry card.

Drafting Template. New bulletin describes maker's electric-control template "No. 312."—RadiDesign, Inc., Box 592, Glendale, Calif.

Circle **566** on inquiry card.

Knurl Cutters. New 4-page illustrated bulletin describes distributor's line of knurl cutters for all machinable metals and plastics, producing diamond, cross, and straight knurls.—Alina Corp., 401 Broadway, New York, N. Y.

Circle **567** on inquiry card.

Milling Machine. New 4-page illustrated Bulletin 11-53-5 lists specifications, features, and accessories of maker's "Model HM-5C-1" horizontal bench milling machine.—Elgin Tool Works, Inc., 1770 Berteau Ave., Chicago, Ill.

Circle **568** on inquiry card.

Vertical Milling Machine. New 4-page illustrated bulletin presents features and specifications of maker's new vertical milling machine with universal head.—Duff Machine Co., 31 Wingate St., Haverhill, Mass.

Circle **569** on inquiry card.

Rods and Chucks. New 4-page illustrated bulletin presents maker's "500 Series" drill extension rod and chucks.—Beaver Tool Co., 622 E. Jericho Turnpike, Huntington Station, N. Y.

Circle **570** on inquiry card.

Plastic Gaskets, Packing, Coating. New 14-page catalog presents features and sizes of maker's forms of "Teflon" packing, seals, gaskets, sheets, tape, film, beading and tubing.—Flexrock Co., Phila. 1, Pa.

Circle **571** on inquiry card.

Packing Seal Rings. New 4-page illustrated Bulletin 77 describes types of "Teflon" packing seal rings.—Flexrock Co., Phila. 1, Pa.

Circle **572** on inquiry card.

Springs. New 16-page illustrated Catalog 8 covers maker's line of custom-made beryllium-copper springs for electrical and mechanical applications, including strip, compression and flat springs. Compares physical properties of beryllium copper and suggestions on spring design.—Instrument Specialties Co., Inc., 231 Bergen Blvd., Little Falls, N. J.

Circle **573** on inquiry card.

New Developments

FOR THE MEASUREMENT OF HIGH FLUID PRESSURES THE HEISE GAUGE OFFERS THE ULTIMATE IN MODERN INSTRUMENT DESIGN

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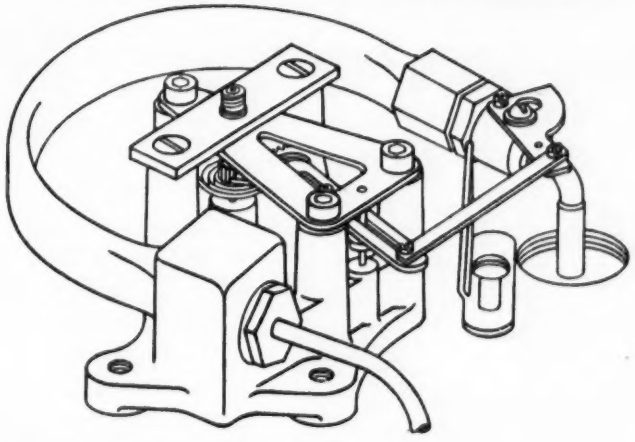

★ Permanent, positive accuracy of alignment guaranteed by integral construction.

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Pressure ranges to 20,000 psi. Sizes: 8½", 12" and 16" Prices from $151.60

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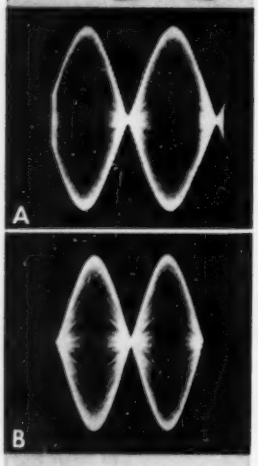
Is the Output of Your
L-F Amplifier Distorted?



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The Servoscope gives you phase and amplitude characteristics even when the wave forms are not sweet and clean sine waves. The phase dial is rotated until the oscillogram **(A)** becomes symmetrical, as at **(B)**, and presto — you have your answer!

Degree and type of distortion are visible, too. For detailed information on how this versatile test instrument can save you man-hours, write Dept. I-4

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NEW HYDE PARK, NEW YORK

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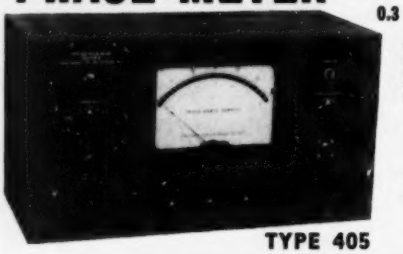
PHASE METER-0.5° Relative Accuracy

0.3 VOLT SENSITIVITY-8 CPS to 100 KC



Type 405 Phase Meter is a simple and convenient device for studying phase relationship between two signals. Very suitable for plotting phase-frequency curves on a cathode ray oscilloscope or a mechanical recorder. Ideal for production work.

SPECIFICATIONS

FREQUENCY RESPONSE: 8 cps to 100 kc. Both the upper and lower limit can be extended with increasing amplitude of both input signals.
ACCURACY: The relative accuracy is ± 0.5°; the absolute accuracy is ± 2° at any range.
INPUT VOLTAGE: 0.3 volt to 70 volts from 8 cps to 100 kc. The lower limit increases exponentially for signals above 20 kc. and below 8 cps.

TYPE 405

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NEW LITERATURE

Electrical Insulation. New 32-page illustrated Class H Catalog covers technical data, descriptions, applications, sizes, and uses of silicone materials for high-temperature Class-H electrical insulation.—Insulation Mfg. Corp., 565 W. Washington Blvd., Chicago, Ill.

Circle **574** on inquiry card.

Silicone Defoamer. New 6-page Bulletin 4-401 presents features and applications of Dow Corning "Antifoam A Spray." Available from distributor. —Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

Circle **575** on inquiry card.

Riveting, Drilling, Wire-stripping. New 8-page illustrated catalog presents engineering data, specifications, applications, and accessories for maker's riveting hammers, tools, drilling machines, staking machines, and wire strippers.—High Speed Hammer Co., Inc., 313 Norton St., Rochester 21, N. Y.

Circle **576** on inquiry card.

Self-lubricating Bushings. New 8-page illustrated bulletin covers applications, features, and characteristics of maker's "Graphalloy" bushings and anti-friction metallic-impregnated graphite.—Graphite Metallizing Corp., Yonkers 3, N. Y.

Circle **577** on inquiry card.

Small-parts Cabinets. New 16-page illustrated bulletin gives description and applications of distributor's "Haz-Bin" line of storage cabinets for small and medium parts.—Herbach & Rademan Inc., 1204 Arch St., Phila., Pa.

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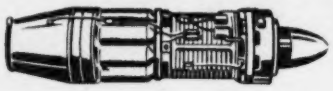

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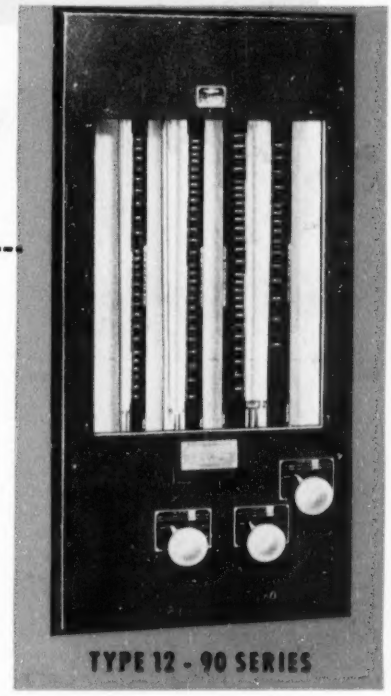

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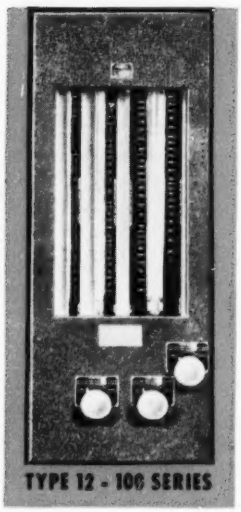

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